

## Logan State Park Electrification and Dock Project

### Index To Specifications

General Civil Specifications are taken from the Montana Public Works Standard Specifications (MPWSS) and are included, but not limited to, the following:

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Floating Dock Specifications are as follows:

#### **Floating Dock**

## **SECTION 01500**

### **CONSTRUCTION**

#### **PART 1: GENERAL**

##### **1.1 CONSTRUCTION DATES**

- A. Contractor shall have all underground conduit and surface grading / re-seeding substantially completed by November 30, 2016.
- B. Contractor shall perform dock installation between April 1st and April 30th 2017.
- C. Contractor shall complete all project work by May 1, 2017.

##### **1.2 CONSTRUCTION SEQUENCE**

- A. The intent of the FWP is to keep the campground open to users during the project. Therefore the contractor shall be limited to working and substantially completing improvements to one loop prior to beginning work in the other. Campers will be directed to make use of the loop that is not under construction.

##### **1.3 STAGING AREA**

- A. As prescribed in Section 1.2.A. above, staging of construction materials and equipment shall be limited to the secured areas of the loop upon which the contractor is working (behind the lockable gates). When contractor finishes the first loop and moves to the second, all materials and equipment shall be moved as well.

##### **1.4 SECURITY**

- A. Provide fencing, barricades, warning signs, and lights to secure all work areas, equipment, and materials.

##### **1.5 WORK HOURS**

- A. Contractor work hours on site shall be limited to occurring between 8 AM and 6 PM weekdays.

##### **1.6 PORTABLE TOILETS**

- A. Contractor shall provide portable toilets for their own employees use.

**PART 2: MEASUREMENT AND PAYMENT**

**4.1 PAYMENT**

- A. All items in Part 1 are incidental to the work and no separate payment is made for these items.

**END OF SECTION**

**PART 2: MEASUREMENT AND PAYMENT**

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**END OF SECTION**

## SECTION 02110

### GEOTEXTILES

#### PART 1: GENERAL

##### 1.1 DESCRIPTION

- A. This work consists of furnishing, and placing a geotextile as a subsurface drainage fabric permeable separator between dissimilar materials (such as between subgrade and sub base/base), stabilization fabric, temporary and/or permanent erosion control measures or as waterproofing/stress releasing membrane within pavement structures.

##### 1.2 REFERENCES

- A. The current publications listed below form part of this specification.

- B. ASTM Standards

D123	Standard Terminology Relating to Textiles
D276	Test Methods for Identification of Fibers in Textiles
D4354	Practice for Sampling of Geosynthetics for Testing
D4632	Breaking; Load and Elongation Of Geotextiles (Grab Method)
D4533	Trapezoid Tearing, Strength of Geotextiles
D3786	Hydraulic Bursting, Strength of Knitted Goods and Nonwoven Fabrics Diaphragm Bursting Strength Tester Methods
D4833	Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
D4491	Water Permeability of Geotextiles by Permittivity
D4751	Determining, Apparent Opening, Size of a Geotextile
D4354	Sampling, of Geotextiles for Testing
D4759	Determining, the Specification Conformance of Geosynthetics
D276	Identification of Fibers in Textiles
D4355	Deterioration of Geotextiles from exposure to ultraviolet light & water (Xenon-arc type apparatus)
D4873	Guide for Identification, Storage and Handling of Geotextiles
D5141	Test Method for Determining Filter Efficiency and Flow rate for Silt Fence Application of a Geotextile Using Site Specific Soils
D5261	Test Methods for Measuring Mass per Unit Area of Geotextiles
D422 & D1140	Particle Size Analysis of Soils
D4318	Determining the Plastic Limit and Plasticity Index of Soils

D698                      The Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb)  
Rammer and a 305-mm (12-in.) drop

C.      ASSHTO Specifications – M288 Geotextile Specifications for Highway  
Applications

1.      Augmenting and prevailing over this specification section.

**PART 2:      PRODUCTS**

2.1      PHYSICAL AND CHEMICAL REQUIREMENTS

- A.      Assure that fibers used in the manufacture of geotextiles, and the threads used in joining geotextiles by sewing, consist of long-chain synthetic polymers, composed of at least 95% by weight polyolefins or polyesters. They must be formed into a network so the filaments on yarns retain dimensional stability relative to each other, including selvages. Furnish materials meeting the physical requirements for the indicated application as described by the corresponding table(s) of properties in ASSHTO M288, Geotextile Specifications for Highway Applications.

2.2      CERTIFICATION

- A.      Assure the manufacturer furnishes the purchaser a certificate stating: the name of the manufacturer, the chemical composition of the filaments or yarns, and other information fully describing the geotextile. The manufacturer must include in the certificate, a guarantee stating that the geotextile furnished meets specifications. The certificate must be attested to by a person having a legal authority to bind the company. Mismatching, or misrepresentation by the manufacturer is reason to reject the geotextile under these specifications. Notice sent to the manufacturer by the purchaser regarding rejection of, will be considered to be notice to all wholesalers, jobbers, distributors, agents and other intermediaries handling the manufacturer's product.
- B.      Label the fabric and its container with the manufacturer's name and fabric type or trade name, lot number and quantity.

2.3      SHIPMENT AND STORAGE

- A.      During shipment and storage, protect the fabric from direct sunlight, ultra-violet rays, temperatures exceeding 160<sup>0</sup>F (71°C), mud, dust and debris. Keep the fabrics in the manufacturer's wrapping until just before use. Include with each shipping, a document, a certification showing that the geotextile meets the

manufacturer's certificate and a guarantee that has been previously filed with the purchaser.

## **PART 3: EXECUTION**

### **3.1 GENERAL**

- A. Where placing geotextiles on native ground, cut the trees and shrubs flush with the ground surface. Do not remove the topsoil and vegetation mat. Remove all sharp objects and large rocks. Fill depressions or holes with a suitable material to provide a firm foundation.
- B. Replace or repair all geotextile that is torn, punctured, or muddy. Remove the damaged area and place a patch of the same type of geotextile overlapping 3 feet, in all directions, (0.9m) beyond the damaged area.

### **3.2 DRAINAGE, SEPARATION AND STABILIZATION APPLICATIONS**

- A. Shape the subgrade to a smooth surface and to the cross section required. Shape slopes to gradually transition into slope adjustments without noticeable breaks. At the ends of cuts, the intersection of cuts, and embankments, adjust slopes in the horizontal and vertical planes to blend into each other or into the natural ground.
- B. Remove all material larger than 6 inches (15 cm) within the top 6 inches (15 cm) of the roadbed. Remove unsuitable material from the roadbed and replace with suitable material. Finish the roadbed and ditches to the required elevation and cross-section.
- C. Place the geotextile smooth and free of tension, stress, or wrinkles. Fold and cut the geotextile to conform to curves. Overlap in the direction of construction. Overlap the geotextile a minimum of 2 feet (0.6m) at the ends and sides of adjoining sheets or sew the geotextile joints according to the manufacturer's recommendations. Do not place longitudinal overlaps below anticipated wheel loads. Hold the geotextile in place with pins, staples, or piles of cover material.
- D. End dump the cover material onto the geotextile from the edge of the geotextile or from previously placed cover material. Do not operate equipment directly on the geotextile. Spread the end-dumped pile of cover material maintaining a minimum lift thickness of 10 inches (250mm). Compact the cover material with rubber-tired or nonvibratory smooth drum rollers. Avoid sudden stops, starts, or turns of the construction equipment. Fill all ruts from construction equipment with additional cover material. Do not regrade ruts with placement equipment.

- E. Place subsequent lifts of cover material in the same manner as the initial lift. Vibratory compactors may be used for compacting subsequent lifts. If foundation failures occur, repair the damaged areas and revert to the use of nonvibratory compaction equipment.

### 3.3 TEMPORARY AND PERMANENT EROSION CONTROL APPLICATIONS

- A. Place and anchor the geotextile on the approved smooth-graded surface. For slope protection, place the long dimension of the geotextile down the slope. For stream bank protection, place the long dimension of the geotextile parallel to the centerline of the channel.
- B. Overlap the geotextile a minimum of 12 inches (300mm) at the ends and sides of adjoining sheets or sew the geotextile joints according to the manufacturer's recommendations. Overlap the uphill or upstream sheet over the downhill or downstream sheet. Offset end joints of adjacent sheets a minimum of 5 feet (1.5m). Pins may be used to hold the geotextile sheets in place. Space pins along the overlaps at approximately 3 foot (1m) centers.
- C. Place aggregate, slope protection, or riprap on the geotextile starting at the toe of the slope and proceed upward. Place riprap onto the geotextile from a height of less than 12 inches (300 mm). Place slope protection rock or aggregate backfill onto the geotextile from a height less than 3 feet (0.9m). In underwater applications, place the geotextile and cover material in the same day.

### 3.4 PAVEMENT APPLICATIONS

- A. Use SS-1 crack filler meeting the applicable section for crack filler for surface preparation of cracks between 1/8-and 1/4-inch wide. Fill cracks exceeding 1/4-inch (6 mm) width with an asphalt emulsion slurry consisting of 20 percent by volume of SS-1, 2 percent by volume Portland cement and the remaining portion fine sand.
- B. Use distributors for spraying a Performance Graded (PG) Asphaltic Binder meeting the specifications for the asphalt cement being used in the asphalt concrete overlay.
- C. Place fabric using manufacturer recommended equipment.
- D. Handle and place all fabric following the manufacturer's recommendations.
- E. Clean pavement to receive fabric of dirt, water and vegetation. Clean all cracks between 1/8-inch (3 mm) and 1/4-inch (6 mm) wide and fill flush to the surface with SS-1 bituminous material. Top with sand. Repair larger cracks or holes



using the asphalt emulsion slurry. Pour the mixture into the cracks until full. Re-fill with slurry, the following day, any cracks which are not completely filled initially. When a leveling course is required, place it before installing the fabric. Areas to be covered with a leveling course do not require surface preparations for cracks unless the leveling courses will be less than 0.3 foot (10cm).

- F. Uniformly apply the asphaltic binder at the rate determined by the Engineer. The quantity will vary with pavement porosity. Take care to place sufficient binder to satisfy the fabric and make the membrane impervious to water without causing a slippage plane. The applications rates are typically 0.25 to 0.30 gallon per square yard. Apply binder using a distributor.
- G. Heat the asphalt binder high enough to permit a uniform spray pattern. Ensure air temperature is at least 50<sup>0</sup> F and rising before applying binder and fabric.
- H. Place the paving geotextile onto the asphalt sealant with minimal wrinkling. Slit, lay flat and tack all wrinkles or folds higher than 1 inch (25 mm). Broom and/or roll the paving geotextile to maximize fabric contact with the pavement surface.
- I. At geotextile joints, overlap the geotextile 1 to 3 inches (25 to 75 mm) to ensure full closure. Overlap transverse joints in the direction of paving to prevent edge pickup by the paver. Apply additional asphalt sealant to paving geotextile overlaps to ensure proper bonding of the double fabric layer.
- J. If asphalt sealant bleeds through the fabric, treat the affected areas with blotter. Minimize traffic on the geotextile. If circumstances require traffic on the fabric, apply blotter and place "slippery when wet" signs.
- K. Broom the excess blotter from the geotextile surfaces before placing the overlay. Repair all damaged fabric before placing overlay. Apply a light tack coat before placing the overlay. To avoid damaging the geotextile, do not turn equipment on the geotextile.
- L. Place a hot asphalt concrete overlay within 48 hours after placing the paving geotextile. Limit the lay-down temperature of the mix to a maximum of 325<sup>0</sup>F (163<sup>0</sup>C) except when the paving geotextile is composed of polypropylene fibers, limit the lay-down temperature of the mix to a maximum of 300<sup>0</sup>F (149<sup>0</sup>C).

## **PART 4: MEASUREMENT AND PAYMENT**

### **4.1 GENERAL**

- A. All geotextiles will be measured by the square yard (square meter) on a plane

parallel to the ground surface, excluding overlaps. The accepted quantities, measured as provided above, will be paid at the contract price per unit of measurement for the pay item that is shown in the bid schedule.

- B. Payment indicated to include complete compensation for all labor, equipment, materials and incidentals required for the completion of the work.

#### 4.2 PAVING FABRICS

- A. Fabric is measured and paid per square yard of roadway surface covered, complete and in place. No allowance is made for additional fabric required for overlap joints. No allowance is made for blotter sand (if occasionally required).
- B. Crack filling is measured per job and payment is at contract lump sum price, complete in place.
- C. Asphalt cement binder is measured and paid by the ton, corrected to standard temperature, complete in place.

**END OF SECTION**

## **SECTION 02112**

### **REMOVAL OF EXISTING PAVEMENT, CONCRETE CURB, SIDEWALK, DRIVEWAY AND/OR STRUCTURES**

#### **PART 1: GENERAL**

##### **1.1 DESCRIPTION**

- A. The work consists of removing and disposing of existing pavement, concrete curb, combined curb and gutter, sidewalk, private driveways, and crosswalks, along with any structures designated for removal in the contract documents. Details of removals are specified in the contract documents.

#### **PART 2: PRODUCTS - NOT USED**

#### **PART 3: EXECUTION**

##### **3.1 GENERAL**

- A. Dispose of all existing pavement, concrete curb, crosswalk and/or combined curb and gutter specified for removal in the contract documents or directed by the Engineer. Exercise care in such removal to assure that remaining nearby facilities and/or structures are not disturbed. Restore to original condition any such existing facilities or structures damaged by construction activities.
- B. Cut, remove and dispose of designated existing pavement to the lines indicated on the contract documents, or directed by the Engineer. Make straight and approximately vertical cuts of edges along which new pavement is to be placed.
- C. Remove and dispose of existing private concrete driveways and/or sidewalks which interfere with construction of street improvements or which do not match new grade as shown on the contract documents or as directed by the Engineer. Remove such driveways and/or sidewalks to a distance of 8 inches (20cm) behind curbs, or to greater distance if required to properly match the new curb and gutter grade. Remove along the neat line produced by a concrete saw cut. Make cuts to depths of at least 25 percent of the concrete thickness and take care in removing the concrete assuring the slab breaks on the sawed neat line.

## **PART 4: MEASUREMENT AND PAYMENT**

### **4. 1 ASPHALTIC CONCRETE PAVEMENT REMOVAL**

- A. Removal and disposal of asphalt concrete pavement is part of Section 2230, Street Excavation, Backfill and Compaction. No separate payment will be made for this item.

### **4. 2 CONCRETE REMOVAL**

- A. Concrete removal and disposal shall be paid for at the contract lump sum price bid, constituting full compensation for all equipment, tools and labor, including the performance of all work to provide incidentals necessary to complete this item.
- B. Measurement and payment for concrete removal and disposal will be made only if listed as a separate pay item in the contract documents. If not listed separately in the contract as a bid item, concrete removal and disposal will be included as part of Section 2230, Street Excavation, Backfilling and Compaction.

### **4. 3 CONCRETE SAW CUT**

- A. Measurement and payment for concrete saw cuttings will be made only if listed as a separate item in the bid documents. If not listed in the contract as a bid item, saw cutting shall be part of the Concrete Removal in Section 4.2 above, or part of the Excavation Above Subgrade item in Section 2230, Street Excavation, Backfill and Compaction, Excavation.

- 4. 4 Payment indicated to include complete compensation for all labor, equipment, materials and incidentals required for the completion of the work.

## **END OF SECTION**

## SECTION 02221

### TRENCH EXCAVATION AND BACKFILL FOR PIPELINES & APPURTENANT STRUCTURES

#### PART 1: GENERAL

##### 1.1 DESCRIPTION

- A. This work is the excavation, trenching and backfilling for pipelines and appurtenances. It includes all clearing, grubbing, site preparation, removal and disposal of debris from the excavation, handling and storing materials for fill and backfill, all bracing, shoring and trench protection, construction dewatering, all backfill, subgrade preparation, final grading, site dressing and cleanup.

##### 1.2 REFERENCES

- A. The current publications listed below form a part of this specification.

AASHTO T99	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-inch (305mm) Drop
ASTM D698	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-inch (305mm) Drop
AASHTO T191 (ASTM D1556)	Density of Soil In-Place by the Sand-Cone Method
AASHTO T310 (ASTM D6938)	In-Place density and water content of the soil and soil aggregate by Nuclear Method (Shallow Depth)
AASHTO T11 (ASTM C117)	Materials Finer Than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T27 (ASTM C136)	Sieve Analysis of Fine and Coarse Aggregate
AASHTO T89	Determining the Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
ASTM D4318	Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils

### 1.3 STANDARD DRAWINGS

A. Standard Drawings applicable to this section are as follows:

1. See plan documents

### 1.4 TESTING

A. Field Density Testing

1. Meet the quality control and quality assurance testing requirements in Section 01400, Contractor Quality Control and Owner Quality Assurance.
2. In-place field density tests for quality assurance are at Owner expense meeting AASHTO T191 (ASTM D1556), Sand Cone Method; or by AASHTO T310 (ASTM D6938) Nuclear Densometer Methods. Quality assurance field density testing frequency is at the Engineer's discretion.
3. Re-testing failing areas is at the expense of the Contractor.
4. At the direction of the Engineer, provide necessary equipment and labor to excavate and replace materials for test holes up to 5 feet deep into the compacted backfill to allow testing below the surface of any layers covered without inspection and approval by the Engineer.

B. Laboratory Maximum Density and Optimum Moisture

1. Quality assurance tests will be made by the Engineer for each on-site natural soil or each source of off-site material, including borrow material, to determine the laboratory maximum density values and optimum compaction moisture content according to AASHTO T-99 or ASTM D698.

C. Material Submittals

1. Submit to the Engineer material quality test results including Type 1 Bedding gradation and plasticity index; and Type 2 Bedding gradation.
2. Submit to the Engineer samples of on-site and off-site borrow soils for laboratory moisture-density relationship testing by the Engineer.
3. If applicable, submit a blasting plan to the Engineer.

## **PART 2: PRODUCTS**

### **2.1 PIPE BEDDING MATERIALS**

#### **A. TYPE 1 PIPE BEDDING**

1. Type 1 Pipe Bedding includes the material placed from 2 inches (50mm) below the bottom of the pipe, around the pipe, and up to 6 inches (150mm) above the top of the pipe.
2. Provide Type 1 Bedding consisting of sand, sandy gravel, or gravel having a maximum 3/4 inch size (19mm) and a maximum plasticity index of 6, determined by AASHTO T89 and T90 or by ASTM D4318.
3. Where trench excavation encounters wet or unstable material, Type 1 Pipe Bedding must be free draining and non-plastic
4. Refer to plan documents and Special Provisions for other requirements.

#### **B. SEPARATION GEOTEXTILE**

1. The plans may require, or the engineer may direct, the use of non-woven geo-textile fabric intended to provide materials separation. The fabric will wrap all or part of the Type 1 Pipe Bedding to prevent materials migrating into the trench bottom and trench walls as shown on the plans or as directed by the engineer. The fabric shall be AASHTO M288 Class 1, 2, or 3 as specified or determined by the Engineer and shall fully comply with MPW Section 2110.

### **2.2 TRENCH BACKFILL MATERIALS**

#### **A. Materials from Trench Excavation**

1. Backfill material obtained from trench excavations must be free of cinders, ash, refuse, organic or frozen material, boulders, or other deleterious materials. Backfill materials and placement are further described in the Execution Section of this specification.

B. Imported Backfill Material

1. Imported backfill material is from borrow source(s) outside the project limits and is used when, in the opinion of the Engineer, an adequate volume of suitable backfill material is not available within the project limits. Imported Backfill Materials must comply with the requirements of Section 2.2.A, MATERIALS FROM TRENCH EXCAVATION.

2.3 FLOWABLE FILL

- A. If used, Flowable Fill is to meet the requirements of MPWSS Section 2225, Flowable Fill.

2.4 DETECTABLE BURIED WARNING TAPE

- A. Detectable buried warning tape is to have a minimum 6 inch (15cm) width and 5 mil (0.12mm) thickness and a solid aluminum core running the full length and width of the tape enclosed in a color coded inert plastic jacket, impervious to alkalis, chemical reagents and solvents in the soil. The tape is to meet APWA/ULCC Color Code requirements and is to have a maximum 36 inch(90cm) imprint.



## **PART 3: EXECUTION**

### **3.1 PROTECTION OF EXISTING PROPERTIES**

#### **A. General**

1. Take precautions to protect all adjoining private and public property and facilities, including underground and overhead utilities, curbs, sidewalks, driveways, structures, and fences. Restore or replace all disturbed or damaged facilities to its original condition at Contractor's expense.
2. Contact utility owners using the Montana One Call System in accordance with Section 01041, PROJECT COORDINATION, Paragraph 1.2.B., for utility locates before starting work. Protect the utilities exposed during the work and prevent damaging underground utilities adjacent to excavations. Immediately notify the utility owner of any construction damage. Repairs of damage to marked utilities are at the expense of the Contractor.
3. Re-locate existing water mains, sanitary sewers and storm drains shown on the plans, that conflict with new pipelines or structures as indicated in the contract documents. No separate payment will be made for this work unless shown as a payment item. If the Owner authorizes the relocation of mains or sewers which are not indicated in the bid documents, and the Engineer determines the work was not included in the original contract, payment will be made under the applicable sections of the General Conditions.
4. Cut and replace existing service lines interfering with trenching operations only with the engineer's permission and at the contractor's expense. Show all repaired and/or adjusted water and sewer lines on the As-Built Plans.
5. Protect existing water and sewer mains and water and sewer services from freezing at all times during construction.

#### **B. Privately Owned Utilities**

1. If any existing private utility interferes with the work in either alignment or grade, and has to be moved, the work will be performed by the appropriate UTILITY Owner, unless otherwise specified in the contract documents. Such private utilities may include gas mains, underground electrical and telephone cables, telephone poles, light poles, etc.

2. If, however, such private utility relocation is performed by the Contractor, and the relocation is not a separate payment item, payment will be made under the Section 02221 conditions covering such changes.
  3. Such payment will be made only if the work is determined by the Engineer to be a change from the original contract work scope.
- C. Existing Structures
1. Prevent damage to existing buildings or structures in the work area. Repair all construction related damage to the satisfaction of the Owner.
- D. Existing Overhead Utilities
1. Use extreme caution to avoid conflict, contact or damage to overhead utilities during the work.
- E. Exploratory Excavation
1. The location of existing buried public utilities may need to be verified by exploratory excavation before construction. Contractor is responsible for all costs incurred.
  2. Exercise care to prevent damaging all utilities and repair any utility damage caused by exploratory excavation.
- F. Pavement Removal and Stripping
1. Where trench excavation or appurtenant structure excavation requires removing curb and gutter, concrete sidewalks, asphalt concrete pavement, or Portland cement concrete pavement, cut the concrete or pavement in a straight line parallel to the excavations edge using a spade-bitted air hammer, concrete saw or other suitable equipment to produce a straight, square and clean break. Re-cut edges broken during construction, before concrete or paving operations.

2. For trenches passing through existing pavement, cut the pavement along a neat vertical line at least 12 inches (30cm) from the trench edge. Where the neat line cut is less than 3 feet (0.9m) from the edge of the existing pavement, remove and replace the entire pavement section between trench and edge of pavement.
  3. Dispose of the asphalt concrete and/or Portland cement concrete debris off-site according to applicable state and local regulations.
- G. When excavating across existing gravel streets or other developed surfaces, remove the surfacing material full depth and stockpile for inclusion as trench backfill or legally dispose of the surfacing material.
- H. When excavating across cultivated or sodded areas, remove topsoil full depth or to a maximum 12 inch (30cm) depth, whichever is less, and stockpile for possible project use.
- I. Re-sod or reseed, as specified in the contract documents, all established lawn areas cut by trenching or damaged during the construction, in accordance with Section 2910, and/or 2920, to the satisfaction of the Engineer.

### 3.2 MAINTENANCE OF FLOWS

- A. Maintain the flow of sewers, drains and water courses encountered during construction. Restore culverts, ditches, fences, crosswalks and structures disturbed by construction to their original condition upon completion of the work.

### 3.3 TRENCH EXCAVATION

#### A. General

1. Meet current OSHA Safety and Health Standards for all excavation, trenching, shoring, and related work.
2. Excavate at the specified locations for pipeline installations and appurtenant structures.
3. Crossings under sidewalks or curbs may be made by tunneling, if approved by the Engineer. If a portion of a sidewalk or curb is removed, use a concrete saw to make joints, compact the backfill as specified, and replace the removed section with new concrete sidewalk or curb.
4. During excavation, stockpile backfill materials away from the trench banks to assure trench wall stability. Stockpile excavated materials on only one side of the trench without obstructing existing fire hydrants,

valves, manholes and other appurtenances. Assure surface drainage of adjoining areas is unobstructed.

5. Remove and dispose of all excess or unsuitable excavated materials.
6. Prevent surface water from flowing into excavations. Promptly remove all water accumulating in trench excavations. Do not permit water to accumulate in any open trench. Remove and re-lay all pipe out of alignment or grade caused by trench flooding.
7. Grade the trench bottoms to the specified lines and grades. Assure bedding material provides uniform bearing and support for each pipe section along its entire length. Excavate for bell and joints after the trench bedding is graded, limiting the excavation to the required length, depth and width for making the particular type of joint used. Backfill over-excavations with Type 2 Bedding Material.
8. No differentiation between common and rock trench excavation is made, except when listed as separate bid items on the bid proposal or bid form. Excavation includes removing and subsequent handling of all earth, gravel, bedrock or other material encountered regardless of the type, character, composition or condition of the material.
9. The use of trench digging machinery is permitted, except in places where its operation is likely to cause damage to existing structures or features, in which case hand methods are to be employed.

#### B. Trench Dimensions

1. Excavate to the trench dimensions specified below.
2. Width
  - a. Excavate to provide room to install and join the pipe as specified. The minimum trench width is 12" (1.1m), for single conduit lines and 24" (2.2m) for multiple conduit trenches.
3. Depth
  - a. Excavate the trench as required for the invert grade or pipe bury as specified in the contract documents.

C. Soft or Unsuitable Trench Subgrade

1. When soft or unstable material is encountered at the trench subgrade which will not uniformly support the pipe, excavate the material to the depth directed by the Engineer and backfill to trench subgrade elevation with Type 1 Pipe Bedding.

D. Blasting

1. Obtain Engineer approval to blast for excavation. If approved, the Engineer will establish the time limits blasting will be permitted.
2. Use utmost care to protect life and property during blasting. Use only a licensed blaster with experience in the type of blasting required for the work.
3. Safely and securely store all blasting materials meeting local laws and ordinances and clearly mark all storage places "Dangerous Explosives". Do not leave any explosives where they could endanger persons or property.
4. Blasting Rock in Trenches
  - a. When blasting rock in trenches, cover the blasting area with earth backfill or approved blasting mats. Before blasting, station workers and provide danger signals to warn people and stop vehicles.
  - b. Assume responsibility for all damage to property and injury to persons resulting from blasting or accidental explosions during the work.
  - c. Furnish the following information to the Owner and Engineer at least 48 hours before the commencement of blasting operations: Name of the contractor's powder man, powder man's experience, type of shot, type of explosives and detonator being used, proof of insurance covering liability for such operation, traffic control plans and planned procedures for protecting the public.
5. Assure blasting plan meets federal, state and local ordinances. Obtain all required permits before blasting starts.

E. Pavement Damage Cause by Equipment

1. Equip all track mounted equipment operated on pavement surfacing with pads to prevent pavement damage.
2. Restore all pavement damaged by construction to its original condition.

F. Shoring, Bracing and Sheeting

1. Provide all shoring, bracing and tight sheeting required to prevent caving and protect workers, meeting current Occupational Safety and Health Act Requirements, and to protect adjacent property and structures. The cost of this work is included in the cost for trench excavation.

G. Excavation for Appurtenances

1. Make excavations for manholes, hydrants, structures and other appurtenances of the size and depth to permit compacting of backfill on all sides to the specified density. The requirements for removing water and other applicable portions of these specifications apply to excavation for appurtenances.

3.4 DEWATERING

- A. Remove all ground water encountered in trench excavations. Do not place pipe, bedding or backfill materials below the groundwater elevation established by dewatering operations. The cost of dewatering operations is considered a part of the excavation cost.

3.5 EXCAVATION STABILITY AND SAFETY

- A. The stability of construction excavations and associated worker safety, including slope geometry and shoring/bracing considerations, are the responsibility of the Contractor. Meet current OSHA regulations. This may require design of temporary slopes and/or shoring by a licensed professional engineer.

3.6 TRENCH FILLING AND BACKFILLING

A. General

1. Backfill all trenches as specified immediately after grade, alignment and pipe jointing has been inspected and approved by the Engineer. Conduct any pipe testing as specified in the respective water distribution, sewerage/drainage sections. Correct all defects discovered by tests prior to backfilling.

B. Pipe Bedding Placement

1. Type 1 Bedding.

- a. Place Type 1 Pipe Bedding material 2 inches (5cm) under the pipe, around the pipe, and up to 6" (15cm) over the pipe. Place in maximum lifts of 6 inches (15cm), using hand operated or other compaction methods without damaging or disturbing the pipe. Thoroughly compact each layer. Use special care to assure compaction under the pipe haunches.
- b. Place backfill material in equal lifts on both sides of the pipe for the full trench width. Take care to prevent migration of Type 1 Bedding into surrounding soils during placement and compaction

2. SEPARATION GEOTEXTILE

- a. Place Separation Geotextile where shown on the plans or where directed by the Engineer.

C. Trench Backfill

- 1. After the pipe bedding materials are placed and compacted as specified, backfill the trench. Use backfill material free of cinders, ash, refuse,

organic or frozen material, boulders, or other deleterious materials. From the top of the Type 1 Pipe Bedding to 6 inches (15cm) below the ground surface, or to the subgrade elevation, material containing rock up to 8 inches (20cm) in the greatest dimension may be used.

2. Trench backfill from the top of the pipe bedding to ground surface or to the street subgrade is separated into three classifications.
  - a. Type A Trench Backfill is compacted backfill typically used in streets or paved areas.
  - b. Type B Trench Backfill is typically used for unpaved alleys, cultivated areas, borrow pits, unimproved streets or other unsurfaced areas, and other areas where compaction is less critical.
  - c. Type C Trench Backfill is typically used in open and unimproved areas outside of the public right-of-way.
3. Meet the backfill and compaction requirements for all of the backfill types described in the contract documents.
4. Watering
  - a. Apply uncontaminated water, when required, at the locations and in the amounts required to compact the backfill material to the specified requirements. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.
  - b. Apply water during the work to control dust and to maintain all embankment and base courses in a damp condition in accordance with these contract documents.
  - c. Water required for compacting trench backfill may be obtained from the municipal system if approved by the Owner, or from other sources.
5. Remove, replace, and re-compact backfill in trenches where settlement has occurred as directed by the Engineer at the contractor's expense.
6. Trench backfill types are designated as follows:
  - a. Type A Trench Backfill. Place trench backfill in maximum 8 inch compacted lifts within 3 percent of optimum moisture content, and compact to at least 95 percent of maximum dry density determined by AASHTO T99 or by ASTM D698.



- b. Type B Trench Backfill. Place backfill in maximum 8 inch (205mm) lifts, within 3 percent of optimum moisture content, and compact to at least 90 percent of maximum dry density, as determined by AASHTO T99 or by ASTM D698.
- c. Type C Trench Backfill. Place and compact Type C Trench Backfill in maximum 12 inch lifts at densities equal to or greater than the densities of adjoining undisturbed soil. Mound earth over the trench top, if so directed by the Engineer.
- d. Flowable Fill. Place flowable fill as trench backfill as shown in the contract documents or as directed by the Engineer. Flowable fill may also be used as a construction expedient, substituting for any type of trench backfill, subject to approval by the Engineer and at the expense of the Contractor.

D. Replacement of Unsuitable Backfill Material

- 1. Remove and dispose of excavated soils that are saturated, contain deleterious materials or have characteristics that, in the opinion of the Engineer, render the soils unsuitable as backfill.
- 2. Replace unsuitable soils with material obtained from trench excavations within the project limits at the expense of the Contractor. If suitable replacement material is not available within project limits, obtain material from an approved borrow source, to be paid for as Imported Backfill Material.
- 3. Place and compact all imported material according to the applicable backfill specification requirements.

E. Backfill of Appurtenances

- 1. Place and compact backfill for appurtenances to finished grade around manholes, inlets, valve boxes and other underground items without disturbing appurtenance alignments.
- 2. Meet the backfill material, placement, and compaction requirements specified for the adjoining trench.

F. Detectable Buried Warning Tape

- 1. The use of warning tape is optional and if used must not be relied on as the primary locating device. Provide warning tape as described in PRODUCTS Section 2.3. Bury tape a maximum 18 inches (45cm) below finish surface grade.

### 3.7 SURVEY MARKERS AND MONUMENTS

- A. Protect all survey markers and monuments. Protection includes marking with flagged high lath and supervising work near markers and monuments. Do not disturb monuments without prior approval from the Engineer.
- B. Replace all Contractor disturbed or destroyed survey markers or monuments, not approved during construction, using a licensed land surveyor. See Section 01050 for details on survey marker protection/disturbance.

### 3.8 CLEANUP

- A. As work progresses, remove debris and complete to finish grade each portion of the work. Once the work is complete, clear debris and finish the entire site to smooth, uniform slopes presenting a neat and workmanlike appearance. Remove and dispose of all rocks brought to the surface during excavation or backfilling.

### 3.9 TIME AND DISTANCE OF OPEN TRENCHES

- A. Perform the work so that trenches will remain open the minimum time required to accomplish the work.
- B. Do not begin trench excavating until appropriate compaction equipment is at the excavation site.
- C. The maximum permissible distance between backfilling/ compaction operations and the end of newly installed pipe is 20 feet (6m) in existing streets (and/or alleys) and 100 feet (30m) in all other areas.
- D. The maximum distance between the newly installed pipe and the excavator is to be 20 feet (6m) in existing streets (and/or alleys) and 100 feet (30m) in all other areas.
- E. For each work group consisting of a trench excavator, a pipe laying crew, and a backfilling/compacting crew, the maximum allowable open ditch at any time is 20 feet (6m) in existing streets (and/or alleys) and 100 feet (30m) in all other areas.

## **PART 4: MEASUREMENT AND PAYMENT**

### **4. 1 GENERAL**

- A. The following items constitute pay items for the work covered under this section. Payment for these items is full compensation for providing all materials, tools, labor and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not.

### **4. 2 TRENCH EXCAVATION AND BACKFILL**

- A. No separate measurement and payment is made for TRENCH EXCAVATION AND BACKFILL. Include all costs for this item in the unit price bid for conduit pipe, complete in-place.
- B. The upper limit of the TRENCH EXCAVATION AND BACKFILL item is defined as the top of subgrade or 6" below surface of topsoiled areas. Details of the various types of surface restoration are found in the contract documents.

### **4. 3 TYPE 1 PIPE BEDDING**

- A. Include approved material for Type 1 Pipe Bedding in the pipe installation price. No measurement or additional payment is made for furnishing or placing Type 1 Pipe Bedding materials.

### **4. 5 IMPORTED BACKFILL MATERIAL**

- A. No separate measurement and payment is made for this item.

### **4. 6 EXPLORATORY EXCAVATION**

- A. Measurement of this item is made for the actual time, to the nearest one-half hour, for which the equipment and personnel are used and authorized by the Engineer for actual exploratory excavation and backfilling operations, including standby time between excavation and backfilling, to allow the Engineer to survey the underground utility.
- B. Payment is made at a to be negotiated price per hour, which includes providing the equipment on-site, with operator and fuel. Where exploratory excavation is outside of planned excavation limits, payment also includes any time required for compaction of the backfill, if necessary.
- C. Surfacing repair will be paid separately, if required.
- D. Payment will be made under: Exploratory Excavation - Per Hour.

#### 4. 7 GEOTEXTILE FABRIC

- A. Measurement and payment for geotextile fabric shall be by the linear foot of trench.
- B. Payment for this item is full compensation for providing all materials, tools, labor and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not.

**END OF SECTION**

## **SECTION 02223**

### **DIRECTIONAL BORING**

#### **PART 1: GENERAL**

##### **1.1 DESCRIPTION**

- A. The work specified in this section consists of furnishing and installing underground utilities using the directional boring (horizontal directional drilling, HDD) method of installation, also commonly referred to as guided horizontal boring. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, restoration of underground utilities and environmental protection and restoration.

##### **1.2 QUALITY ASSURANCE**

- A. The requirements set forth in this document specify a wide range of procedural precautions necessary to insure that the very basic, essential aspects of a proper directional bore installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification. Adherence to the specifications contained herein, or the Engineer's approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the work authorized under the Contract.

#### **PART 2: EQUIPMENT REQUIREMENTS**

##### **2.1 GENERAL**

- A. The directional boring equipment shall consist of a directional boring rig of sufficient capacity to perform the bore and pullback the pipe, a boring fluid mixing & delivery system of sufficient capacity to successfully complete the crossing, a guidance system to accurately guide boring operations and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project.

##### **2.2 BORING SYSTEM**

- A. **BORING RIG:** The directional boring machine shall consist of a hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill

(bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing. The hydraulic power system shall be self-contained with sufficient pressure and volume to power boring operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The rig shall be grounded during boring and pull-back operations. Sufficient spares shall be kept on hand for any break-downs which can be reasonably anticipated.

- B. BORE HEAD: The bore head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and boring fluid jets.
- C. MUD MOTORS (if required): Mud motors shall be of adequate power to turn the required boring tools.
- D. DRILL PIPE: Shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36 RC.

## 2.3 GUIDANCE SYSTEM

- A. The Guidance System shall be of a proven type and shall be setup and operated by personnel trained and experienced with this system. The Operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system if using a magnetic system.

## 2.4 BORING FLUID (MUD) SYSTEM

- A. MIXING SYSTEM: A self-contained, closed, boring fluid mixing system shall be of sufficient size to mix and deliver boring fluid composed of bentonite clay, potable water and appropriate additives. Mixing system shall be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. Mixing system shall continually agitate the boring fluid during boring operations.
- B. BORING FLUIDS: Drilling fluid shall be composed of clean water and an appropriate additive. Water shall be from a clean source with a pH of 8.5 - 10. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No hazardous additives may be used. Boring fluid shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of bore wall.

- C. **DELIVERY SYSTEM:** The mud pumping system shall be capable of delivering the boring fluid at a constant minimum pressure. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used boring fluid and boring fluid spilled during boring operations shall be contained and properly disposed of. A berm, minimum of 12" high, shall be maintained around boring equipment, boring fluid mixing system, entry and exit pits and boring fluid recycling system (if used) to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess boring fluid from containment areas to storage facilities.

## 2.5 OTHER EQUIPMENT

- A. **PIPE ROLLERS:** Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull-back operations. Sufficient number of rollers shall used to prevent excess sagging of pipe.
- B. **PIPE RAMMERS/PULLERS:** Hydraulic or pneumatic pipe rammers or pullers may only be used if necessary and with the authorization of Engineer.
- C. Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the Engineer prior to commencement of the work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stop- page and to maintain line and grade within the tolerances prescribed by the particular conditions of the project.

## PART 3: EXECUTION

### 3.1 GENERAL

- A. The Engineer must be notified 48 hours in advance of starting work. The Directional Bore shall not begin until the Engineer is present at the job site and agrees that proper preparations for the operation have been made. The Engineer approval for beginning the installation shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the work as authorized under the Contract. It shall be the responsibility of Engineer to provide inspection personnel at such times as appropriate without causing undue hardship by reason of delay to the Contractor.

### 3.2 PERSONNEL REQUIREMENTS

- A. All personnel shall be fully trained in their respective duties as part of the directional boring crew and in safety. Training shall be provided specific to the project if any potential hazards may be encountered which has not already been included in personnel's training.

### 3.3 BORING PROCEEDURE

- A. **SITE PREPARATION:** Prior to any alterations to work-site, contractor shall photograph or video tape entire work area, including entry and exit points. One copy of which shall be given to Engineer and one copy to remain with contractor for a period of one year following the completion of the project.

Work site as indicated on drawings, within right-of-way, shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made. Contractor shall confine all activities to designated work areas.

- B. **BORE PATH SURVEY:** Entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on drawings. If contractor is using a magnetic guidance system, drill path will be surveyed for any surface geo-magnetic variations or anomalies.
- C. **ENVIRONMENTAL PROTECTION:** Contractor shall place silt fence between all boring operations and any drainage, wetland, waterway or other area designated for such protection by contract documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or boring fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. Contractor shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within 200' of any water-body or wet- land.
- D. **UTILITY LOCATES:** Contactor shall notify all companies with underground utilities in the work area via the state or local "one-call" to obtain utility locates. Once the utilities have been located Contractor shall physically identify the exact location of the utilities by vacuum or hand excavation, when possible, in order to determine the actual location and path of any underground utilities which might be within 20 feet of the bore path. Contractor shall not commence boring operations until the location of all underground utilities within the work area have been verified.
- E. **SAFETY:** Contractor shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner. Safety meetings shall be conducted at least weekly with a written record of attendance



and topic submitted to Engineer.

- F. PIPE: Pipe shall be connected together in one length prior to pull-back operations, if space permits. Steel pipe welds will be X-rayed prior to being placed in bore hole. Pipe will be placed on pipe rollers before pulling into bore hole with rollers spaced close enough to prevent excessive sagging of pipe.
- G. PILOT HOLE: Pilot hole shall be drilled on bore path with no deviations greater than 5% of depth over a length of 100'. In the event that pilot does deviate from bore path more than 5% of depth in 100', contractor will notify Engineer and Engineer may require contractor to pull-back and re-drill from the location along bore path before the deviation.

In the event that a boring fluid fracture, inadvertent returns or returns loss occurs during pilot hole boring operations, contractor shall cease boring, wait at least 30 minutes, inject a quantity of boring fluid with a viscosity exceeding 120 seconds as measured by a Marsh funnel and then wait another 30 minutes. If mud fracture or returns loss continues, contractor will cease operations and notify Engineer. Engineer and contractor will discuss additional options and work will then proceed accordingly.

- H. REAMING: Upon successful completion of pilot hole, contractor will ream bore hole to a minimum of 25% greater than outside diameter of pipe using the appropriate tools. Contractor will not attempt to ream at one time more than the boring equipment and mud system are designed to safely handle.
- I. PULL-BACK: After successfully reaming bore hole to the required diameter, contractor will pull the pipe through the bore hole. In front of the pipe will be a swivel. Once pull-back operations have commenced, operations must continue without interruption until pipe is completely pulled into bore hole. During pull-back operations contractor will not apply more than the maximum safe pipe pull pressure at any time.

In the event that pipe becomes stuck, contractor will cease pulling operations to allow any potential hydro-lock to subside and will commence pulling operations. If pipe remains stuck, contractor will notify Engineer. Engineer and contractor will discuss options and then work will proceed accordingly.

### 3.4 PIPE TESTING

- A. Installed pipe shall be continuous without joints and subject to pressure test at the discretion of the Engineer.

### 3.5 SITE RESTORATION

- A. Following boring operations, contractor will de-mobilize equipment and restore the work-site to original condition. All excavations will be backfilled and compacted to 95% of maximum dry density. Landscaping will be restored to original.

## **PART 4: MEASUREMENT AND PAYMENT**

### 4.1 GENERAL

- A. Installed and finished work shall be measured and paid in the units described in the bid documents.

**END OF SECTION**

## SECTION 02230

### STREET EXCAVATION, BACKFILL AND COMPACTION

#### PART 1: GENERAL

##### 1.1 DESCRIPTION

- A. This work is the clearing and grubbing, excavation, filling or backfilling, and subgrade preparation to the specified lines, grades and cross sections as preparation for overlying base course or other courses as shown in the contract documents. Also included are the removal and disposal of debris and excess soil, the furnishing and placement of fill materials, and compaction.

##### 1.2 REFERENCES

- A. The current publications listed below are a part of this specification.

AASHTO T99	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-inch (305mm) Drop
ASTM D698	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-inch (305mm) Drop
AASHTO T191 (ASTM D1556)	Density of Soil In-Place by the Sand-Cone Method
AASHTO T310 (ASTM D6938)	In-Place density and water content of the soil and soil aggregate by Nuclear Method (Shallow Depth)
AASHTO T11 (ASTM C117)	Materials Finer Than No. 200 (0.075mm) Sieve in Mineral Aggregates by Washing
AASHTO T27 (ASTM C136)	Sieve Analysis of Fine and Coarse Aggregate
AASHTO T89	Determining the Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
ASTM D4318	Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils

### 1.3 DENSITY CONTROL TESTING

#### A. Field Density Testing

1. Meet the quality control and quality assurance testing requirements in Section 01400, Contractor Quality Control and Owner Quality Assurance.
2. In-place field density tests for quality assurance are at Owner expense meeting AASHTO T191 (ASTM D1556), Sand Cone Method; or AASHTO T310 (ASTM D6938), Nuclear Densometer Methods. Quality assurance field density testing frequency is at the discretion of the Engineer.
3. Retesting of failing areas is at the expense of the Contractor.

#### B. Laboratory Maximum Density and Optimum Moisture

1. Quality assurance tests will be made by the Engineer for each on-site natural soil or each source of off-site material, including borrow material, to determine the laboratory maximum density values and optimum compaction moisture content under AASHTO T99 or ASTM D698.

#### C. Material Submittals

1. Submit to the Engineer results of gradation tests for Subexcavation/Replacement Below Subgrade pitrun gravel/sand.
2. Submit to the Engineer samples of soils and/or aggregates for laboratory moisture-density relationship testing by the Engineer.

## **PART 2: PRODUCTS**

### 2.1 ON-SITE EMBANKMENT

- A. Fill and backfill materials are to consist of natural soils free from organic matter, frozen material, refuse, construction debris or other man-made items. Obtain approval of the Engineer for all fill before placing and use only the fill from designated borrow areas.

## 2.2 IMPORTED BORROW MATERIALS (FOR EMBANKMENTS IN-PLACE)

- A. If required, obtain borrow soil for embankments from areas off the project site. Furnish imported borrow at Contractor expense. Obtain Engineer approval of borrow areas. Imported borrow is to meet the requirements of Section 2.1, On-Site Embankment.

## 2.3 SUBEXCAVATION/REPLACEMENT BELOW SUBGRADE

- A. Sub-excavation consists of removing and disposing of unstable material from below planned subgrade elevation in cut sections or from below the natural ground line in embankment sections.
- B. Replacement material for subexcavations consists of either:
  - 1. Suitable materials from within the project limits if suitable material is present within the project limits, or
  - 2. Imported materials if suitable material is not present within the project limits. Where imported pitrun gravel is used, furnish replacement material meeting the following gradation requirement:

<u>Sieve Opening</u>	<u>% Passing</u>
3 Inch	100
No. 4	25 - 60
No. 200	12 Max.

## PART 3: EXECUTION

### 3.1 CLEARING AND GRUBBING

- A. Perform clearing and grubbing including the excavation, removal and disposal of roots, stumps, sod, or any organic material and buried debris from within construction limits. Remove unsuitable material to at least 12 inches (30cm) below subgrade elevation.
- B. Stockpile for project use any topsoil removed by clearing and grubbing.
- C. Dispose of all Clearing and Grubbing material as specified.

### 3.2 EXCAVATION STABILITY AND SAFETY

- A. Meet OSHA requirements for excavations and excavated material stockpiles. This may require design of temporary slopes and/or shoring by a licensed professional engineer.

### 3.3 PROTECTION OF PROPERTY

- A. Take precautions to protect all adjoining private and public property and facilities, including underground and overhead utilities, curbs, sidewalks, driveways, structures, fences, and vegetation. Any disturbed or damaged facilities will be suitably restored or replaced consistent with condition(s) which existed prior to construction.

### 3.4 EXCAVATION

- A. Excavate to the specified lines and grades. Excavate without causing rutting, pumping or other disturbance to underlying materials.
- B. Excavation made outside the specified grade limits is not measured for payment in the Excavation or Embankment In-Place quantities.
  - 1. Restore subexcavated areas as directed by the Engineer. Correct subgrade disturbance by removing the disturbed soil and replacing and compacting to reach at least 95% of the maximum laboratory dry density determined by AASHTO T99 or ASTM D698.
  - 2. Correct subgrade disturbance before placing overlying fill, backfill, base course or other courses. Disturbed soils may be replaced with imported material approved by the Engineer and compacted to 95% of maximum laboratory dry density determined by AASHTO T99 or ASTM D698.
- C. Maintain the subgrade to drain at all times. Construct side ditches or gutters from cuts to embankments to prevent erosion damage to embankments.
- D. Construct and maintain temporary drainage where existing surface drainage, sewers, or under-drainage are disturbed during the work until permanent drainage facilities are completed. Protect and preserve all existing drains, sewers, sub-surface drains, conduits, gas lines, and other underground structures which may be affected by the work. Repair all damage to these facilities or structures resulting from the work, to the satisfaction of the Engineer.

- E. Excavate to minimize foundation soil and/or subgrade soil exposure to erosion, drying or infiltrating moisture. Perform excavation to provide drainage away from foundation/subgrade soils and minimize the potential for surface runoff to enter the foundation/subgrade soils.
- F. Grade all intersecting streets and approaches within the project limits as specified or as directed using suitable materials on the surfaces to produce smooth riding and satisfactory approaches to the intersections.

### 3.5 DISPOSAL OF EXCAVATED MATERIAL

- A. Dispose of debris and unused excavated materials off the project site in accordance with all applicable state and local regulations. Locate and provide suitable disposal areas.

### 3.6 DUST CONTROL

- A. Furnish dust control meeting Section 01500, Construction and Temporary Facilities, requirements.

### 3.7 SUBGRADE PREPARATION AND COMPACTION

#### A. General

1. Assure the subgrade beneath pavements, curb, or sidewalks is natural soil free of topsoil, organic material or refuse. Place pavement components, curb and sidewalk over the prepared subgrade as soon as practical. Do not place pavement components on frozen subgrade. No separate payment is made for subgrade preparation, since it is considered incidental to construction of overlying pavements/structures.
2. If the surface of a previous roadbed or pavement surface matches the surface of the finished subgrade, scarify the top 6 inches (15cm) of the previous surface the full width of the subgrade to permit uniform reshaping and compaction.

#### B. Fine Grading

1. Assure the finished surface does not deviate not more than 0.1 foot (3cm) at any point from the staked elevation; and that the sum of the deviations

from true grade of any two points less than 30 feet (9m) apart does not exceed 0.1 foot (3cm).

C.     Compaction

1.     Compact the upper 8-inches (20cm) of the subgrade to at least 95% of the laboratory maximum, determined by AASHTO T99 or ASTM D698. Proof roll the subgrade surface for observation by the Engineer. Compact all soft, yielding or otherwise unstable areas to provide adequate support of construction equipment as determined by the Engineer. Also compact the subgrade to meet the specified density requirements. Remove and replace any unstable or otherwise unsuitable subgrade as specified under Section 3.9, Subexcavation/Replacement Below Subgrade.

3.8     EMBANKMENT PLACEMENT AND COMPACTION

A.     General

1.     Place fill materials (embankment) to the specified lines and grades. Place fill in uniform layers not exceeding 8 inches (20cm) in loose thickness. Once placed, moisten or aerate, mix, and compact each layer as specified. Work clay soils to maximum 2-inch (5cm) nominal size before compacting. Do not begin fill placement until the subgrade construction has been approved by the Engineer. Do not place fill on wet or frozen areas. Do not operate heavy equipment for spreading or compacting fill within four feet (1.2m) of structures.
2.     If grading operations are suspended due to weather, blade the entire area until it is smooth, free of depressions and ruts, and crowned to drain water.

B.     Compaction

1.     Control the fill moisture content to assist in obtaining the specified field density. Maintain the moisture content of fill soils within  $\pm 3$  percent of optimum moisture. Compact each fill layer and the top 8 inches (20cm) of subgrade soil to at least 95% of maximum laboratory density as determined by AASHTO T99 or ASTM D698. Compact areas within four feet (1.2m) of structures in maximum 8 inch (20cm) loose lifts using power-driven hand held tampers.



2. Apply water, when required, at the locations and in the amounts required to compact the material to the specified requirements, Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application. Apply water during the work to control dust and to maintain all embankment and base courses in a damp condition in accordance with MPWSS Section 1500. Water required for compacting subgrade and/or embankments may be obtained from the municipal system if approved by the Owner, or from other sources.
3. Do not place fill or embankment when moisture content prevents effective compaction or causes rutting. Dry all embankments having excessive moisture by scarifying and blading the affected areas before compacting or placing succeeding layers.

### 3.9 SUBEXCAVATION/REPLACEMENT BELOW SUBGRADE

- A. Subexcavation consists of removing and disposing of unsuitable material from below planned subgrade elevation in cut sections or from below the natural groundline in embankment sections.
- B. Soil is unsuitable if, in the opinion of the Engineer, it contains excessive organics, refuse, construction debris, or other objectionable material; or if it unstable, rutting or yielding; or if it contains excessive moisture. Generally, soils will be sub-excavated and replaced only if they are unable to adequately support equipment typically used for excavation and soil transport.
- C. Do not backfill any area where unstable foundation soils have been excavated until authorized by the Engineer. Backfill placed without approval may be ordered removed and replaced at Contractor expense.
- D. Backfill with either suitable soils from within the project limits or imported pitrun gravel complying with the requirements of Section 2.3, Subexcavation/Replacement Below Subgrade.
- E. Compact the replacement material to 95 percent of the maximum laboratory density as determined by AASHTO T99 or ASTM D698.

### 3.10 PROTECTION OF THE WORK

- A. Repair damaged embankments to the specified elevations and grades. Maintain ditches and drains along the subgrade to drain the subgrade. Assure the finished grade does not deviate more than 0.1 (3cm) foot at any point from the staked elevation and the sum of the deviations from true grade of any two points not more than 30 feet (9m) apart does not exceed 0.1 foot (3cm). Do not place any surface course or pavement until the subgrade has been checked and approved by the Engineer.

## **PART 4: MEASUREMENT AND PAYMENT**

### 1.1 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

#### A. EXCAVATION ABOVE SUBGRADE

- 1. Excavation Above Subgrade is not specified in the contract as a bid item, the cost of excavation above subgrade is incidental to and included in the unit prices bid for the associated bid items for the work.

#### B. EXCAVATION/REPLACEMENT BELOW SUBGRADE

- 1. Excavation and/or replacement below subgrade is not specified in the contract as a bid item, the cost of excavation and replacement below subgrade is incidental to and included in the unit prices bid for the associated bid items for the work.

#### C. EMBANKMENT IN PLACE.

- 1. Embankment In Place is not specified in the contract, the cost of constructing embankments is incidental to and included in the unit prices bid for the associated bid items for the work.

## **END OF SECTION**



## SECTION 02234

### SUB BASE COURSE

#### PART 1: GENERAL

##### 1.1 DESCRIPTION

- A. This work is constructing a sub-base course of either crushed or uncrushed materials meeting the specified gradations and other quality criteria specified herein.

##### 1.2 REFERENCES

AASHTO T11	Amount of Material Finer Than No. 200 (0.075 mm) Sieve in Aggregate
AASHTO T27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO T89	Determining Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T176	Sand Equivalent Value of Soils and Fine Aggregate
AASHTO T96	Resistance to Degradation By Abrasion and Impact in the Los Angeles Machine
AASHTO T99 (ASTM D698)	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5 kg) Rammer and 12-Inch (305 mm) Drop
ASTM D5821	Determining the Percentage of Fractured Particles in Coarse Aggregate
AASHTO T191 (ASTM D1556)	Density of Soil in-Place By Sand Cone Method
AASHTO T310 (ASTM D6938)	In-Place density and water content of the soil and soil aggregate by Nuclear Method (Shallow Depth)

##### 1.3 DENSITY CONTROL TESTING

- A. Field Density Testing
1. Meet the quality control and quality assurance testing requirements in section 01400, Contractor Quality Control and Owner Quality Assurance.
  2. In-place field density tests for quality assurance are at Owner expense meeting AASHTO T191 (ASTM D1556) Sand Cone method or AASHTO

T310 (ASTM D 6938), Nuclear Densometer method. Quality assurance field density testing frequency is at the discretion of the Engineer.

3. Retesting of failing areas is at the expense of the Contractor.

**B. Laboratory Maximum Density and Optimum Moisture**

1. Moisture density curves will be provided by the Contractor for each base material supplied. These will be provided at the expense of the Contractor.

**C. Materials Submittals**

1. Submit to the Engineer gradations, moisture density curves and other preliminary test results for sources to be used for base materials prior to delivery to the site for approval by the Engineer. If recycled materials are proposed, CBR test data must be submitted to the Engineer to assure consistency with design requirements.

**PART 2: PRODUCTS**

**2.1 GENERAL**

A. Furnish select sub-base material meeting the applicable aggregate quality.

**2.2 UNCRUSHED SUBBASE**

A. Furnish material consisting of hard, durable stone, gravel or other similar materials mixed or blended with sand, stone dust, recycled concrete and/or asphalt or other binding or filler materials produced from approved sources, providing a uniform mixture meeting these specifications and compacted into a dense and well- bonded sub base. Oversize material of acceptable quality may be crushed and used in the base material, if the blend meets the specified gradations.

B. Assure the material retained on the No.4 sieve has a wear not exceeding 50 percent at 500 revolutions as determined by AASHTO T96.

**2.3 CRUSHED SUBBASE**

A. Furnish material having both fine and coarse crushed stone or crushed gravel, and/or natural gravel, and when approved, blended with soil, sand, screenings, recycled concrete and/or asphalt or other materials.

B. Furnish crushed gravel or stone consisting of hard, durable particles, not containing excessive flat, elongated, soft or disintegrated rock, dirt, or other

deleterious matter, and having a wear not exceeding 50 percent at 500 revolutions as determined by AASHTO T96.

- C. Use production methods that produce a percent of fractured rock in the finished product that is constant and uniform. Crush aggregate so that at least 25% of the material is retained on the No.4 sieve and has one or more mechanically fractured faces.

## 2.4 GRADATION

- A. Produce material, including any added binder or filler, meeting the following Table of Gradations as determined by AASHTO Methods T11 and T27:

### TABLE OF GRADATIONS

#### PERCENTAGES BY WEIGHT PASSING SQUARE MESH SIEVES

Passing	4" Minus	3" Minus	2" Minus	1 1/2" Minus	1" Minus
4 Inch	100				
3 Inch	---	100			
2 Inch	---	---	100		
1 1/2 Inch	---	---	---	100	
1 Inch	---	---	---	---	100
No.4	25-60	25-60	25-60	25-60	25-70
No.40	10-30	10-30	10-30	10-30	10-30
No.200	2-10	2-10	2-10	2-10	2-10

- B. Up to 5% "oversized" material is permitted provided that the "oversized" material passes the screen size immediately larger than the top size specified. The material between the maximum screen opening and the No.4 sieve shall be reasonably well graded.
- C. Suitability of the aggregate is determined by the gradation testing of material placed in the project as required in the Contract documents, within the allowable limits described by the Table of Gradations for the particular grading specified.
- D. Assure the liquid limit for the aggregate fraction passing a No.40 sieve does not exceed 25, nor the plasticity index exceed 6, as determined by AASHTO T89 and T90.

## 2.5 WATERING:

- A. Use uncontaminated water.

## **PART 3: EXECUTION**

### **3.1 PREPARATION**

- A. Immediately before placing the base course, blade smooth and shape the underlying subgrade, sub-base or base course to the plan cross section before the base course is placed on the street. Do not place sub-base course on wet or muddy subgrade or sub-base course. Maintain at least one completed area of finished and accepted subgrade or sub-base course in advance of placing base course.

### **3.2 PLACEMENT AND SPREADING**

- A. Mix and place the material in maximum 6-inch (15 cm) horizontal layers loose thickness. Deposit and spread each load of material on the prepared subgrade, or on a completed sub-base course layer continuously without breaks. Assure hauling over the subgrade or over any completed sub base course does not damage the subgrade, sub-base or base course.
- B. Spread using dump boards, spreader boxes, or moving vehicles equipped to distribute the material in a uniform layer or a windrow. Place and spread the material in a uniform layer to the specified depth without causing segregation. Once the base course is spread, blade-mix it the full depth by alternately blading the entire layer to the centerline and back to the roadway edge.
- C. For multiple layers, mix each layer as specified above. Blade smooth and compact each layer before placing the succeeding layer.
- D. Uniformly add water, when required, on site and place in amounts required to compact the material as necessary to aid in densification and to limit segregation. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.
- E. Apply water during the work to control dust and to maintain the base course in a damp condition.
- F. Where crushed sub-base is specified, produce a product with at least 25% of the material retained on the No.4 sieve having one or more fractured faces.
- G. Water required for compacting base gravel may be obtained from the municipal system if approved by the Owner, or from other sources.
- H. Compact the material using appropriate tamping equipment or power rollers. Correct all irregularities or depressions that develop under rolling by scarifying the material and adding or removing material, as required, until the surface meets specifications.

- I. Blade and compact alternately, as required to produce the specified surface until final inspection. Tamp the material along curbs, headers, manholes, and similar structures and all places inaccessible to rollers using approved mechanical tampers or hand tampers meet field density requirements.

### 3.3 FIELD DENSITY REQUIREMENTS

- A. Furnish watering and rolling to obtain a minimum field density of 95 percent of the maximum dry density determined by AASHTO T99. No separate compensation is allowed for rolling and watering the sub-base course other than the sub-base course bid item or items listed on the Contract documents.

### 3.4 SURFACE TOLERANCES

- A. Finish the sub-base course so that when tested using a 10-foot (3 m) straight edge placed on the surface with its center line parallel to the street center, the maximum surface deviation from the straight edge does not exceed 1/2-inch (12.7 mm). Additionally, the finished grade cannot deviate more than 0.1 foot (30 mm) at any point from the staked elevation and the sum of the deviations from two points not more than 30 feet (9.14 m) apart cannot exceed 0.1 feet (30 mm).
- B. Perform all sub base course corrections to meet the above tolerances using approved methods and materials. Payment for patching aggregate is at the unit price bid for the sub-base course material.

## **PART 4: MEASUREMENT AND PAYMENT**

### 4.1 SQUARE YARD BASIS: SUB BASE COURSE

- A. This item is measured and paid for by the square yard of sub base surface area for furnishing crushed or uncrushed, sub-base course of the thickness and gradations specified, complete in place, at the contract unit price bid for thickness specified in plan documents which constitutes full compensation for furnishing, loading, hauling, spreading, shaping, blending, watering and compacting the sub-base course material, and for all tools, labor and incidentals necessary to complete this item.

## **END OF SECTION**



**SECTION 02235**  
**CRUSHED BASE COURSE**

**PART 1: GENERAL**

**1.1 DESCRIPTION**

- A. This work is the placing of one or more base courses composed of crushed gravel, stone or other similar materials meeting the gradation and other quality criteria specified herein.

**1.2 REFERENCES**

AASHTO T11	Amount Finer than No. 200 (0.075 mm) Sieve in Aggregate
AASHTO T27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO T89	Determining Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T176	Sand Equivalent Value of Soils and Fine Aggregate
AASHTO T96	Resistance to Degradation By Abrasion and Impact in the Los Angeles Machine
AASHTO T99 (ASTM D698)	Moisture-density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5 kg) Rammer and 12-Inch (305 mm) Drop
ASTM D5821	Determining the Percentage of Fractured Particles in Coarse Aggregate
AASHTO T191 (ASTM D1556)	Density of Soil In-Place By Sand Cone Method
AASHTO T310 (ASTM D6938)	In-Place density and water content of the soil and soil aggregate by Nuclear Method (Shallow Depth)

**1.3 DENSITY CONTROL TESTING**

- A. Field Density Testing
1. Meet the quality control and quality assurance testing requirements in section 01400, Contractor Quality Control and Owner Quality Assurance.
  2. In-place field density tests for quality assurance are at Owner expense meeting AASHTO T191 (ASTM D1556) Sand Cone method or AASHTOT310 (ASTM ( D6938) Nuclear Densometer method. Quality

assurance field density testing frequency is at the discretion of the Engineer.

3. Retesting of failing areas is at the expense of the Contractor.

**B. Laboratory Maximum Density and Optimum Moisture**

1. Moisture density curves will be provided by the Contractor for each base material provided. These will be provided at the expense of the Contractor.

**1.4 MATERIALS SUBMITTALS**

1. Submit to the Engineer gradations, moisture density curves and other test results for sources to be used for base materials prior to delivery to the site for approval by the Engineer. If recycled materials are proposed, CBR test data must be submitted to the Engineer to assure consistency with design requirements.

**PART 2: PRODUCTS**

**2.1 GENERAL**

- A. Furnish aggregate base material meeting the applicable aggregate quality requirements.

**2.2 CRUSHED BASE MATERIAL**

- A. Consists of both fine and coarse fragments of crushed stone or crushed gravel, and/or natural gravel, and when approved, blended with sand, finely crushed stone, crusher screenings, recycled concrete and/or asphalt or other similar materials.
- B. Use crushed stone or gravel consisting of hard, durable particles of fragments of stone, free of excess of flat, elongated, soft or disintegrated pieces, dirt, or other deleterious matter, and having a percent of wear of not exceeding 50 at 500 revolutions when tested under AASHTO T96.
- C. Crush material so that the percentage of fractured particles in the finished product is as constant and uniform as practical. Crush to produce material where at least 35 percent of the material retained on the No. 4 sieve has at least one fractured face.
- D. Incorporate all material produced in the crushing operation and passing the No. 4 mesh sieve into the base material necessary to meet the gradation requirements.

## 2.3 GRADATION

- A. As determined by AASHTO Methods T11 and T27, furnish material for the grading specified in the contract documents including binder or filler, which may have been added at the plant or at the site, meeting the requirements of that grading in the Table of Gradations below:

**TABLE OF GRADATIONS**

**PERCENTAGES BY WEIGHT PASSING SQUARE MESH SIEVE**

<u>Passing</u>	<u>1 1/2" Minus</u>	<u>1" Minus</u>	<u>3/4" Minus</u>
1 1/2 Inch	100		
1 Inch	—	100	
3/4 Inch	—	—	100
1/2 Inch	—	—	—
No. 4 Sieve	25 - 60	40 - 70	40 - 70
No. 10 Sieve	—	25 - 55	25 - 55
No. 200 Sieve	0 - 8	2 - 10	2 - 10

- B. Up to 5% "oversized" material is permitted provided that the "oversized" material passes the screen size immediately larger than the top size specified. The produced material between the maximum screen opening and the No.4 sieve shall be reasonably well graded.
- C. Suitability of the aggregate is based on samples obtained during placement in the project within limits allowed in the table for the particular grading specified.
- D. That portion of the fine aggregate passing the No. 200 sieve must be less than 60 percent of that portion passing the No. 40 sieve.
- E. The liquid limit for that portion of the fine aggregate passing a No. 40 sieve cannot exceed 25, nor the plasticity index exceed 6, as determined by AASHTO T89 and T90.

## 2.4 WATERING:

- A. Use uncontaminated water.

## PART 3: EXECUTION

### 3.1 GENERAL

- A. Before placing the base course, smooth and shape the surface of the underlying subgrade, sub-base or base course to the cross section shown on the plans before placing the base course.
- B. Do not place base course on a wet or muddy subgrade or sub-base course. Complete at least one area of finished and accepted subgrade, sub-base or underlying base before the placing of any base course.

### 3.2 PLACEMENT AND SPREADING

- A. Mix and place the material in maximum 8 inches (20 centimeters) compacted layers unless otherwise approved. Deposit and spread each load of material on the prepared subgrade, or on a completed sub-base or base course layer continuously without interruption. Discontinue operating haul units over subgrade, or over any sub-base or base course completed if the haul units damage the subgrade, sub-base or base course.
- B. Deposit and spread the material in a uniform layer, without segregation, to a loose depth so that when compacted, and making allowance for any filler to be blended on the road, the layer has the specified thickness.
- C. Spread material using dump boards, spreader boxes, or vehicles equipped to distribute the material in a uniform layer. The material may be deposited in windrows mixed and spread as described below.
- D. Construct each layer meeting these requirements. Blade smooth and thoroughly compact each layer as specified before placing the succeeding layer.
- E. If segregation or moisture problems exist, or if the material was placed on the road in windrows, thoroughly blade-mix the material of the affected layer by alternately blading to the center and back to the edges of the street.
- F. Uniformly add water, when required, on site and place in amounts required to compact the material as necessary to aid in densification and to limit segregation. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.
- G. Apply water during the work to control dust and to maintain the base course in a damp condition in accordance with Section 01500 under Dust Control.
- H. Water required for compacting base gravel may be obtained from the municipal system if approved by the owner, or from other sources.

### 3.3 FIELD DENSITY REQUIREMENTS

- A. Compact placed material the full width by rolling with suitable tamping equipment or power rollers. Correct all irregularities or depressions that develop during rolling by loosening the material in these places and adding or removing material, as required.
- B. Perform blading and compacting alternately as required or directed, to maintain a smooth, even, uniformly compacted surface until the final inspection. Along curbs, headers, manholes, and similar structures, and at all places not accessible to the roller, compact the base course material with suitable mechanical tampers or hand tampers to reach the compaction requirements.
- C. Provide the watering and rolling required to obtain a minimum field density of 95 percent of maximum dry density as determined by AASHTO T99. No separate compensation is made for rolling and watering the base course other than the base course bid item or items listed on the contract documents.

### 3.4 SURFACE TOLERANCES

- A. The base course surface when finished and tested with a 10-foot (3.0 meter) straight edge placed on the surface with its center line parallel to the center line of the street, will not have a surface deviation from the straight edge exceeding 3/8- inch (1.0 centimeter). Additionally, the finished grade cannot deviate more than 0.05 feet (1.5 centimeters) at any point from the staked elevation, and further, the sum of the deviations from two points not more than 30 feet (9.0 meters) apart cannot exceed 0.05 feet (1.5 centimeters).
- B. For base course receiving asphalt concrete surfacing, the finished grade cannot deviate more than 0.02 feet (0.6 centimeters) at any point from the staked elevations, and the sum of the deviations from two points not more than 30 feet (9.0 meters) apart cannot exceed 0.02 feet (0.6 centimeters).
- C. If patching of the base course is necessary to meet the tolerances, perform patching using methods and aggregates approved by the Engineer. Payment for patching aggregate is at the unit price bid for the base course material.

## **PART 4: MEASUREMENT AND PAYMENT**

### 4.1 SQUARE YARD BASIS: CRUSHED BASE COURSE.

- A. This item is measured and paid for by the square yards of crushed base course surface area for furnishing crushed base course of the thickness and gradations specified in the Contract documents, complete in place, at the contract unit price bid in contract documents. Price and payment is full compensation for furnishing, crushing, loading, hauling, spreading, shaping, watering and compacting the base course material, and for all tools, labor and incidentals necessary to complete this item.

**END OF SECTION**

## SECTION 02510

### ASPHALT CONCRETE PAVEMENT

#### PART 1: GENERAL

##### 1.1 DESCRIPTION:

- A. This Work is the production and placement of plant mix asphalt concrete pavement.
- B. Hot plant mix asphalt concrete is a mineral aggregate and asphalt material mixed at a central hot plant meeting these specifications and placed in one or more courses on a newly prepared or existing street roadway in accordance with the contract documents.

##### 1.2 REFERENCES:

AASHTO T11 (ASTM D1140)	Amount of Material Finer than No. 200 (0.075 mm) Sieve in Aggregate
ASTM D5361	Standard Practice for Sampling Compacted Bituminous Mixtures for Laboratory Testing
AASHTO T27 (ASTM C136)	Sieve Analysis of Fine and Coarse Aggregate
AASHTO T89 (ASTM D4318)	Determining Liquid Limit of Soils
AASHTO T90 (ASTM D4318)	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T283 (ASTM D4867)	Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage
AASHTO T176 (ASTM D2419)	Sand Equivalent Value of Soils and Fine Aggregate
AASHTO T245 (ASTM D6926, D6927)	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
AASHTO T96 (ASTM C131)	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D2041	Theoretical Maximum Specific Gravity and Density of Bituminous Mixtures
ASTM C1097	Hydrated Lime for Use in Asphaltic Concrete Mixtures
ASTM D3666	Evaluating and Qualifying Agencies Testing and Inspecting
ASTM D5821	Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM C123	Lightweight Particles in Aggregate
ASTM D6307	Asphalt Content of Hot Mix Asphalt by Ignition Method
STM C142	Clay Lumps and Friable Particles in Aggregates
MS-2	Asphalt Institute – Mix Design Methods

## **PART 2: PRODUCTS**

### **2.1 GENERAL:**

- A. The Asphalt Concrete Surface Course must have at least a 3-bin separation, when continuous flow mixing types of plants are used. When a drum dryer is used with a weight batching system from dry bins, separate and stockpile the crushed aggregate into two sizes.
- B. The specific type and grading of aggregate shall be as indicated on the plans or in the contract documents. The types and grades are described in this specification.
- C. The furnishing of asphalt materials for use in asphaltic concrete mixes shall meet the requirements for the particular grade specified in the contract documents. The types and grades are described in this specification.
- D. Prepare pavement course to conform to the lines, grades, thickness and typical cross sections shown in project documents and plans, and shall be rolled, finished, and approved by the Engineer before the placement of the next course.

### **2.2 PLANT MIX AGGREGATES**

- A. Furnish aggregates from acceptable sources approved by the Engineer.
- B. Furnish test data as outlined in this section on each source to be used for acceptance by the Engineer.
- C. Designation of the source of supply and the acceptability of the material there from, does not extend to the grading of the material as it may naturally come from the pit or crusher. Adjust the crusher and screens to remove certain portions of the material as may be necessary to furnish gravel that will comply with the specifications in the contract. No additional compensation will be allowed for such adjustment of the equipment or the rejection of waste. It is understood that the Engineer may order procurement of material from any portion of any area designated as a pit site and may reject portions of the deposit as unacceptable.
- D. Aggregate materials shall not contain more than 1.5% by weight of clay lumps, shale, or coal, nor shall light weight particles exceed 3.5% by weight. No combination of clay, shale, coal, or lightweight particles shall exceed 3.5% by weight. Do not use Scoria (fired clay). Aggregate materials shall conform to the grading stipulated in the contract documents. Use reasonable care in the selection of material in a pit so that uniform product will be produced at all times. No compensation will be allowed for such stripping of the pit as may be required in order that satisfactory material may be secured.

- E. Aggregate used shall consist of gravel, crushed to the specified size, crushed stone, composed of hard durable pebbles or stone fragments, reclaimed asphalt pavement, and finely crushed stone filler, sand or natural clean material, or other fine mineral material. The portion of the material retained on the No. 4 sieve (4.74 mm) will be called coarse aggregate and that passing the No. 4 sieve (4.74 mm) and retained on the #200 sieve (0.075 mm) will be called fine aggregate. The material passing the #200 (0.075 mm) will be called mineral filler. The reclaimed asphalt pavement shall be removed from its original location and reduced by suitable means to such particle size as may be required for use in hot plant mix asphalt concrete.
- F. For all gradings of fine aggregate, including any blended fine aggregate and mineral filler, passing a No 40 sieve (0.425 mm), shall have a liquid limit not exceeding 25 and a plasticity index of not more than 6.
- G. Produce coarse aggregate retained on the No. 4 sieve (4.75 mm) having a minimum of 50% by weight of particles with at least one mechanically fractured face. The coarse aggregate shall not exceed 40% wear at 500 revolutions.
- H. Preliminary acceptance of aggregates proposed for use may be made at the point of production. Final acceptance will be made only after tests of the aggregates are complete and in place.
- I. Surface Course Asphalt Plant Mix Aggregate:

**TABLE 1**

**REQUIREMENTS FOR GRADING OF SURFACE COURSE AGGREGATE**

Percentage by Weight Passing Job Mix Target Bands						
Sieve Size	Type A	Type B		Type C		Job Mix Tolerances
1" (25.0 mm)	100	---		---		---
3/4" (19.0 mm)	91-93	100		---		+/- 7
1/2" (12.5 mm)	76-89	83-93		100		+/- 7
3/8" (9.5 mm)	61-79	73-87		91-93		+/- 7
No 4 (4.75 mm)	41-54	47-63		51-71		+/- 6
No 10 (2.00 mm)	31-39	32-43		34-46		+/- 6
No 40 (0.425 mm)	16-27	15-25		16-26		+/- 5
No 200 (0.075 mm)	4-7	5-7		5-9		+/- 2

1. The above gradation bands represent the job mix target limits, which determine the suitability of aggregate for use. The final job mix target



gradation must be within the specified bands and uniformly graded from coarse to fine and not vary from the low limits on one screen to the high limits on the adjacent screen, or vice versa. The final job mix gradation limits are established by applying the job mix tolerances to the job mix targets.

2. The job mix formula establishes target values. During production of the mix, the gradations shall lie within the job mix gradation limits specified in Table 1. For example, "Type A, No. 200" band is "4-7". QA job mix target of 5 has been selected for the final mix. The job mix gradation limits is 5, plus and minus 2. Therefore, the job mix gradation limits for production is 3-7.

## 2.3 ASPHALT BINDER MATERIAL

- A. Furnish Asphalt binder material to be used as specified in the contract documents that meet the type and grade specified requirements in this section in Table 3.
  1. Grades:
    - a. (PGAB) PG 58-22
    - b. (PGAB) PG 58-28
    - c. (PGAB) PG 64-22
    - d. (PGAB) PG 64-28 (Polymer Modified)
- B. The percentage of asphalt by weight, to be added to the aggregate will be, generally, between 4 and 8 percent of the weight of the total mix. The mix design will establish the exact percentage of asphalt in the mix, based upon preliminary laboratory tests, sieve analysis and grading and character of the aggregate furnished within the specification limits. No claim is allowed for the payment for rejecting any batch or load of mixture containing an excess or deficient amount of asphalt binder varying more than 0.4 of a percent from the fixed mix design percentage.
- C. Obtain Engineer approval of the asphalt material source before shipments are made to any project. The source of supply cannot change after work is started unless approved in writing by the Engineer. The Engineer is not liable for the quantity shipped.
- D. Samples of asphalt binder material may be taken, as directed by the Engineer, and placed in uncontaminated one-quart containers. When sampled, these shall be taken from the tanker car or truck at the point of delivery on the project and submitted to the Engineer.
- E. All transport vehicles must be equipped with a spigot or gate valve installed in either: (1) the unloading line, (2) in the tanker at the centerline on the tank, (3) in

the pressure line from the unloading pump, or other locations approved by the Engineer. Assure the spigot or gate valve has a diameter of between 3/8 inch (1 cm) and 3/4 inch (2.5 cm). The spigot valve must be located to prevent contamination from plant dust or other contaminants.

- F. The supplier furnishing the asphalt binder material shall inspect each tanker car or truck before it is loaded and ship only in clean, uncontaminated, fully insulated cars or trucks, sealed after loading by the supplier.
- G. The material supplier shall issue, in duplicate, a certificate showing full compliance with the specifications for the designated grade of material, together with the following information. Project number, date of shipment, source of the material, car or truck initial and number, destination, gross quantity loaded, loading temperature, and net quantity in gallons at 60° F (15.5° C) or tons, whichever unit of measurement is stipulated. Assure the certificate of compliance accompanies the shipment and is furnished to the Engineer. The certificate, signed by the supplier representative, must also certify that the conveyance vessel was inspected and found to be free of contaminating material.
- H. The certificate of compliance is the basis for tentative acceptance and use of the material. Samples taken according to applicable sampling methods and retained by the Engineer may be tested at the Engineer's discretion. Failure of the asphalt material to meet these specifications may result in rejection of the entire, associated work. If rejected, removed and replace rejected work.
- I. Apply asphalt material at temperatures that assure uniform mixing or spreading. Application temperature ranges for each grade of material should be accompanied with the mix design. Application temperature for mixing applications will be in accordance with the mix design.
- J. Upon request by the Engineer, furnish the Engineer and/or laboratory (responsible for completing the mix design) with data or a report showing the temperature-viscosity relationship of each asphalt binder used on the project. Assure this data covers the range of temperatures used for mixing and compaction. In addition, the Engineer may request a complete set of test results from Table 3 for each grade used on the project.

**TABLE 3**  
**PERFORMANCE GRADED ASPHALT BINDER (PGAB)**

Performance Grade	PG 58		PG 64		Test Methods
	-22	-28	-22	-28	
Average 7-day Maximum Pavement Design Temperature, °C	<58		<64		
Minimum Pavement Design Temperature, °C	>-22	>-28	>-22	>-28	
Original Binder					
Flash Point Temp.: Minimum °C	230				AASHTO T48
Viscosity: Maximum, 3 Pa ·s (3000 CP), Test Temp, °C	135				ASTM D4402
Dynamic Shear: G* / sin delta, Minimum, 1.00 kPa Test Temp @ 10 rad / s, °C	58		64		AASHTO TP5
Rolling Thin Film Oven (AASHTO T240) or Thin Film Oven (T179) Residue					
Mass Loss, Maximum, %	1.0				AASHTO T240
Dynamic Shear: G* / sin delta, Minimum, 2.20 kPa Test Temp @ 10 rad / s, °C	58		64		AASHTO TP5
Pressure Aging Vessel Residue (AASHTO PP1)					
PAV Aging Temp, °C	100		100		AASHTO PP1
Dynamic Shear: G* / sin delta, Maximum, 5000 kPa Test Temp @ 10 rad / s, °C	22	19	25	22	AASHTO TP5
Creep Stiffness <sup>a</sup> : S, Minimum, 300 MPa m-value, Minimum, 0.300 Test Temp, @ 60 sec, °C	-12	-18	-12	-18	AASHTO TP1
Direct Tension <sup>a</sup> : Failure Strain, Minimum, 1.0%, Test Temp @ 1.0 mm/min. °C	-12	-18	-12	-18	AASHTO TP3

- a. If creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

## 2.4 HYDRATED LIME FOR ASPHALT CONCRETE.

- A. Mineral filler may be incorporated in the asphalt concrete mixture. Furnish hydrated lime as filler when specified. Assure it is free of lumps and extraneous material and meets the following gradation requirements as per ASTM D242:

<u>Sieve</u>	<u>Percent Passing</u>
No. 30 (0.60 mm) Sieve	100
No. 80 (0.180 mm) Sieve	95-100
No. 200 (0.075 mm) Sieve	70-100

- B. Assure the hydrated lime meets paragraph 2 (chemical composition) and paragraph 7 (a) requirements (chemical analysis) of ASTM C1097.
- C. Where required, the mineral filler will be effectively mixed with the hot plant mix asphaltic concrete.

## 2.5 COMPOSITION OF MIXES:

### A. General

1. Submit to the Engineer for approval a mix design for each mix required on the project. Assure the job-mix formula is within the gradation limits in Part 2 Products in this Section.
2. Have the job-mix formula prepared by an independent testing laboratory approved by the Engineer. The requirements of ASTM D-3666 are the guidelines for testing laboratory approval. The cost of the job-mix formula(s) is at Contractor expense.
3. Keep the job mix formula current and contain the following minimum information:
  - a. Gradation of all constituent aggregates.
  - b. Specific gravity of constituent aggregates and asphalt cement.
  - c. Source of supply of all materials and grade of Asphalt Cement.
  - d. Marshall design curves for stability, unit weight, flow and volumetric requirements (VMA and total voids) at asphalt contents below and above optimum (four points minimum).
  - e. Measured voidless (Rice's) specific gravity used in voids computations.
  - f. Composite aggregate grading.
  - g. Recommended asphalt cement content.
  - h. Marshall compactive effort (50 blows).
  - i. Date of mix design (job mix formula).
  - j. Index of retained strength.

4. In addition to the job mix formula, all asphalt concrete surfacing mix submittals will have laboratory tests indicating that the Tensile Strength Ratio (TSR) as determined by AASHTO T-283, is at least 70%. Test shall be performed at 7.0 +/- 1% air voids and shall include the freeze cycle.

**B. Asphalt Concrete Surface Course**

1. The maximum permissible variation from the job-mix formula within the specification limits is as follows:
  - a. Aggregate Gradation . . . . . Within Job Mix Tolerances
  - b. Asphalt . . . . .  $\pm 0.4$  percent\*
  - c. Temperature of Mix . . . . .  $\pm 20^\circ \text{F}$ .

\* This tolerance will be permitted only if the job mix parameter curves indicate that the corresponding Marshall design limits are not exceeded.
2. Produce Hot Plant Mix Asphalt Concrete Surface courses having the following characteristics as measured by AASHTO T245, ASTM D6726 & D6927 “Resistance to Plastic Flow of Bituminous Mixtures by Means of the Marshall Apparatus”:
  - a. Number of compaction blows, each end of specimen.....50.
  - b. Stability, minimum .....1200.
  - c. Flow .....8 – 18.
  - d. Air voids, percent..... 3-5.
  - e. Percent voids in mineral aggregate (minimum). . . . See Table 4.

<b>TABLE 4</b>	
<b>REQUIRED VOIDS IN MINERAL AGGREGATE (VMA)</b>	
Nominal particle size (table 2)	Voids in Mineral Aggregate, Min.
3/8 – inch (9.5 mm)	14
1/2 - inch (12.5 mm)	13
3/4 - inch (19.0 mm)	12
1 – inch (25.0 mm)	11
1 1/2 - inch (37.5 mm)	10
Nominal maximum particle size is one size larger than the first sieve to retain more than 10 percent.	

## **PART 3: EXECUTION**

### **3.1 CRUSHING:**

#### **A. Crushing Equipment**

1. Fit crushing plant-screening equipment, when required, with blowers or other devices capable of removing excess and undesirable fines.

#### **B. Screening Plants**

1. Screening plants consist of a revolving trommel screen, shaker screen, vibrating screen, or other devices capable of removing oversize material, excess and undesirable fines.

#### **C. Scales**

1. Furnish scales, when required, satisfactory to the Engineer. Test and certify scales prior to their use on the project and as often thereafter as the Engineer may consider necessary to insure their accuracy. Have on hand not less than ten, 50-pound weights for testing scales.
2. House the recording devices of the scales in a suitable manner. Place the scales in a location suitable to facilitate accurate weighing of loads. The scales shall be accurate to one-half of one percent at any weight. Alternate methods or devices for weighing may be acceptable, provided that these methods or devices produce the same degree of accuracy as required of platform scales.

### **3.2 MATERIAL HANDLING:**

- A. All work involved in clearing and stripping pits and quarries, including handling unsuitable material encountered, are performed with no additional compensation being allowed for this work. The pits as utilized shall immediately be opened so as to expose the vertical faces of the various strata of acceptable material and, unless otherwise directed, the material shall be secured in successive vertical cuts extending through all the exposed strata.
- B. Provide, unless otherwise specified, material containing as large a proportion as possible of crushed aggregate. Combine the crushed material with the screened material to obtain a uniform product.
- C. No material will be accepted which is loaded into hauling units in a segregated condition or which does not meet the required grading. In case the material deposit contains sand or other material in excess of the specification gradation requirements, or of an unacceptable quality, such excess or undesirable material

shall be removed and disposed of prior to crushing, or during screening operations, if crushing is not required.

- D. Provide a storage bin of ample capacity to insure uniform quality and delivery of material. Loading of trucks directly from the conveyor belt, from the crusher or screening plant will not be permitted.

### 3.3 STOCKPILES:

- A. Grub and clean sites for aggregate stockpiles prior to storing aggregates. Assure the site is firm, smooth and well drained. Maintain a bed of aggregate suitable to avoid the inclusion of soil or foreign material.
- B. Build up coarse aggregate stockpiles in tiers of not more than 4 feet (1.2 m) in thickness. Assure each tier is completely in place before the next tier is placed. Do not allow material to “cone” down over the next lower tier.
- C. Dumping, casting or pushing over the sides of stockpiles will be prohibited, except in the case of fine aggregate stockpiles.
- D. Space stockpiles of different gradations of aggregate far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates.
- E. Any method of stockpiling aggregate, which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate, will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated and failure of such samples to meet all grading requirements for the aggregate discontinuance of such stockpiling procedures.
- F. Transfer the aggregate from the stockpiles in such a manner that uniform grading of the material is preserved.

### 3.4 CONVEYOR STOCKPILING:

- A. Materials stockpiled by conveyors shall be deposited in a succession of merging-cone piles. Do not drop material over 12 feet (3.66 m) nor allow cones to exceed 12 feet (3.66 m) in height. Cones should be leveled to a thickness of approximately 4 feet (1.2 m) prior to starting another tier.

### 3.5 TRUCK STOCKPILING:

- A. Materials stockpiled by trucks shall construct the stockpile in tiers approximately 4 feet (1.2 m) in thickness. Complete each tier before the next tier is started.

### 3.6 ASPHALT MIXING PLANTS:

- A. Use mixing plants of either the weight batching type, the continuous flow mixing type, or drum dryer type. Use drum dryer mixers specifically designed and constructed for producing hot mix.
- B. Equip all plants with approved conveyors, power units, aggregate handling equipment, aggregate screens and bins that are coordinated and operated to produce a uniform mixture within the specified job mix tolerances.
- C. Use batch-type plants having a minimum batch production capacity of 2,000 pounds (900 kg). Use continuous flow or drum dryer plants having a minimum production capacity of 60 tons per hour (27 kg per hour). These capacity requirements may be modified if specified in the Contract Documents.
- D. Stop production and remove from the project mixing plants that fail to continuously produce a mixture meeting requirements as specified.

### 3.7 INSPECTION AND CONTROL OF ASPHALT MIXING PLANT:

- A. For verification of weights and measures, character of materials and determination of temperatures used in the preparation of the paving mixes, the Engineer or his authorized representative will, at all times, have access to all portions of the mixing plant, aggregate plant, storage yards and other facilities for producing and processing the materials for the work. All sampling and testing of processed and unprocessed material is performed in accordance with the provisions of the Contract Documents.

### 3.8 MIX DESIGN:

- A. The Owner's acceptance testing agency will make gradation analyses of the completed mix to assure that the materials being produced and used are within the tolerances of the mix design and the specifications of the mix being used.

### 3.9 SAMPLING AND TESTING FOR ACCEPTANCE:

- A. Sampling and testing of aggregates or other constituent materials will be performed by the Owner's testing agency at a frequency determined by the owner or the owner's representative. Marshall field control is performed under AASHTO T245, ASTM D6926 & D6927. Field density testing is by core testing for acceptance purposes. Densities to conform to Section 2510, 3.28. Gradations to be within the job mix gradation limits. Oil content to be within 0.4 percent of the Marshall Mix Design.



- B. Samples will be used to verify compliance with the requirements set forth in this Section. If there is a dispute, a third party testing firm may be retained by the contractor for additional retesting.

### 3.10 WEATHER LIMITATIONS:

- A. When the moisture in the stockpiled aggregate or the dryer adversely effects the quality of mix production, normal plant operations, or when pools of water are observed on the base, mixing and placing of hot-mix asphalt is prohibited.
- B. Do not place asphalt hot-mix surface course mixture when the air temperature is less than 40° F (4° C) and rising. Do not place asphalt hot-mix base course mixtures of compacted lifts 4 inches (10 cm) or more when the air temperature is less than 30° F (-1° C) and rising. Do not place asphalt upon a surface which is frozen or that has a temperature of less than 32° F (0 ° C). Do not place paving during rainfall or in standing water.

### 3.11 SURFACE PREPARATION:

- A. Assure the area to be paved is true to line and grade and has a dry and properly prepared surface before starting paving operations. Assure the surface is free from all loose screenings and other loose or foreign material.

### 3.12 NEW WORK:

- A. For new work, meet the surface preparation requirements in Sections 02230, 02234 or 02235 of these specifications. Prime prepared soil or aggregate bases if indicated as a bid item in the Contract Documents.
- B. Before paving, proof-roll the base with equipment having at least one 18 kip single axle load or equivalent. Excavate and replace areas that yield or crack under these wheel loads as directed. This does not replace or relax the base or subgrade compaction requirements.
- C. Paint the surfaces of curbs and gutters, vertical faces of existing pavements and all structures in contact with asphalt mixes with a thin coating of asphaltic material to provide a water-tight joint.

### 3.13 OVERLAYS OVER EXISTING PAVEMENTS AND OLD BASE:

- A. Where a base is rough or uneven, place a leveling course using a paver or motor grader and compact before the placing of subsequent courses.
- B. When specified, place construction fabric to control reflective cracking, as detailed, meeting Section 02110.3.4 Pavement Overlay Applications.

- C. When a leveling course is not specified, patch or correct all depressions and other irregularities, subject to the Engineer's approval, before starting other paving operations. Remove all rich and unsuitable patches, excess crack or joint filler, and all surplus bitumen from the area to be paved. Do not blot excessive deposits of asphalt with sand or stone.
- D. Apply a tack coat when the surface to be paved is an existing portland cement concrete, brick or asphalt pavement. When a tack coat is required, use the asphalt material indicated, at the rate specified in Section 02502.
- E. Coat the surfaces of curbs and gutters, vertical faces of existing pavements and all structures in actual contact with asphalt mixes with a thin, complete coating of asphalt material to provide a water-tight joint.

### 3.14 PATCHING:

- A. Weather Limitations
  - 1. Follow procedures set out in section 3.10.
- B. Surface Preparations
  - 1. Assure the area to be paved is true to line and grade, is dry and properly prepared surface before starting paving operations. Clean the surface of all loose screenings and other loose or foreign material.
  - 2. Before paving, proof roll the base. Areas that yield excessively or crack under such wheel loads will be excavated and replaced, to correct yielding and cracking problems. This does not replace the base or subgrade compaction requirements. Cut the edge of existing pavements against which additional pavement is to be placed straight and vertical.
  - 3. Minimum standards for patching new or existing pavement include the following:
    - a. Neatly cut all asphalt edges using a asphalt saw.
    - b. Cut asphalt edges to form as regular a patch shape as practical and should, in general, approximate a rectangle.
    - c. Cut asphalt edges at least 30 cm (12 inches) wider than the trench width on each side of trench excavations; and, in general, be cut parallel to the street centerline for mainline construction and perpendicular to the street centerline for service lateral construction.
  - 4. Remove and replace asphalt surface widths of less than 3 feet (90 cm).

C.     Compaction

1.     Compact to a density equal to or greater than 92 percent of Maximum Theoretical Density (RICE) as determined by ASTM D2041.

3.15   TRANSPORTATION OF MIX:

- A.     Transport the mix in vehicles cleaned of all foreign material which may affect the mix. The truck beds must be painted, or sprayed with a lime-water, soap or detergent solution at least once a day or as often as required. After this operation elevate the truck bed and thoroughly drain it, with no excess solution being permitted. Dispatch the vehicles so that all material delivered is placed in daylight, unless the Engineer approves artificial light. Deliver material to the paver at a uniform rate and in an amount well within the capacity of the paving and compacting equipment.

3.16   SPREADING AND FINISHING:

- A.     Spread and finish meeting the following requirements
  1.     The maximum lift thickness is 2 1/2 inches (6.5 cm) for surface courses and 5 inches (13 cm) for base courses.

3.17   MECHANICAL PAVERS:

- A.     Spread and strike off the base and surface courses with a mechanical paving machine. Operate the paving machine so that material does not accumulate and remain along the sides of the receiving hopper.
- B.     Do not use equipment, which leaves tracks or indented areas, which cannot be corrected in normal operation, produces flushing or other permanent blemishes, or fails to produce a satisfactory surface.
- C.     Construct longitudinal joints and edges to true line markings. Establish lines for the paver to follow in placing individual lanes parallel to the centerline of the proposed roadway. Position and operate the paver to follow closely the established lines.
- D.     When using pavers in echelon, assure the first paver follows the marks or lines with the second paver following the edge of the material placed by the first paver. To assure a hot joint and obtain proper compaction, assure the pavers work as close together as possible not exceeding 100 feet (30 m) apart. In backing trucks against the paver, take care not to jar the paver out of its proper alignment.

- E. As soon as the first load of material has been spread, check the texture of the unrolled surface to determine its uniformity. Segregation of materials is not permitted. If segregation occurs, suspend spreading operation until the cause is determined and corrected.
- F. Offset transverse joints in succeeding courses at least 2 feet (0.6 m). Offset longitudinal joints at least 6 inches (15 cm).
- G. Correct all irregularities in alignment left by the paver by trimming directly behind the machine. Immediately after trimming, thoroughly compact the edges of the course by tamping. Avoid distorting the pavement during this operation.
- H. Assure edges against which additional pavement is to be placed is straight and approximately vertical. Use a lute or covered rake immediately behind the paver, when required, to obtain a true line and vertical edge. Correct all irregularities in the surface of the pavement course directly behind the paver. Remove excess material forming high spots by a shovel or lute. Fill low areas with hot mix and smooth it with the back of a shovel being pulled over the surface. Fanning of material over such areas is not permitted.

### 3.18 MOTOR GRADER:

- A. When motor graders are used for the spreading of leveling courses, place the material on the roadbed so that the proper amount of material is available. Spread the mix to the required thickness, line and grade, with a uniform surface texture, while at a workable temperature.

### 3.19 HAND SPREADING:

- A. In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand, if so directed by the Engineer. Wood or steel forms, approved by the Engineer, rigidly supported to assure correct grade and cross section, may be used. In such instances, measuring blocks and intermediate strips must be used to obtain the required cross-section. Perform hand placing carefully. Uniformly distribute the material to avoid segregation of the coarse and fine aggregate. Broadcasting of material is not permitted. During the spreading operation, loosen and uniformly distribute all material using lutes or covered rakes. Reject material that has formed into lumps and does not break down readily. Following placing and before rolling, check the surface with templates and straightedges and correct all irregularities.
- B. Maintain on the project heating equipment for keeping hand tools free from asphalt. Exercise caution to prevent heating that may burn the material. Assure the temperature of the tools when used is not greater than the temperature of the mix being placed. Use heat only to clean hand tools; petroleum oils or solvents are not permitted.

### 3.20 COMPACTION:

- A. Furnish the number of rollers necessary to provide the specified pavement density. During rolling, keep the roller wheels moist to avoid picking up the material.
- B. After the longitudinal joints and edges have been compacted, start rolling longitudinally at the sides and progress toward the center of the pavement. For transverse graded streets, begin rolling on the low side and progress to the high side, overlapping passes by at least one-half the width of rollers and uniformly lapping each preceding pass. Operate the rollers at a slow, uniform speed with the drive roll or wheel nearest the paver. Do not exceed 3 miles per hours (4.8 km per hour).
- C. Do not quickly change the line of rolling reversing direction suddenly. If rolling displaces the material, re-work the area using lutes or shovels and restore it the original grade of the loose material before re-rolling. Do not permit heavy equipment or rollers to stand on the finished surface before it has been compacted and has thoroughly cooled.
- D. When paving in single width, roll the first lane placed as follows:
  - 1. Transverse joints
  - 2. Outside edge
  - 3. Initial or breakdown rolling, beginning on the low side and progressing toward the high side
  - 4. Second rolling, same procedure as 3
  - 5. Finish rolling
- E. When paving in echelon, or abutting a previously placed lane, perform the longitudinal joint rolling the same as transverse joint rolling.
- F. When paving in echelon, leave 2 or 3 inches (5 to 7.5 cm) of the edge unrolled, which the second paver can match unrolled. Then the joint between the lanes can be rolled together. Do not leave edges exposed more than 15 minutes without being rolled.
- G. In laying a surface mix adjacent to any finished area, place it high enough so that, when compacted, the finished surface is true and uniform.
- H. On slight grades, check gutters with a straightedge and test with running water to assure drainage to the planned outlet.

- I. The average density shall be equal to or greater than 93 percent of the maximum density as determined by ASTM D2041 and no individual sample shall be less than 92 percent of maximum density.

### 3.21 TRANSVERSE JOINTS:

- A. Construct and compact transverse joints to provide a smooth riding surface. Joints will be straight edged and string lined to assure smoothness and true alignment.
- B. Joint formed with bulkheads to provide a straight line and vertical face will be checked with a straightedge before fresh material is placed against it to complete the joint. If bulkheads are not used to form the joint and the roller is permitted to roll over the edge of the new material, locate the joint line in back of the rounded edge the distance required to provide a true surface and cross-section. If a joint has been distorted by traffic or by other causes, trim it to line. Paint the joint face with a thin coating of asphalt before the fresh material is placed against it.
- C. Place the material against the joints vertical face with the paving machine positioned so that the material overlaps the edge of the joint 1 to 2 inches (2.5 to 5 cm). Maintain a uniform depth of the overlapped material . Remove and dispose of the coarse aggregate in the overlapped material that dislodged during raking.
- D. Position rollers on the previously compacted material transversely so that no more than 6 inches (15 cm) of the rolling wheel rides on the edge of the joint. Operate the roller to pinch and press the mix into place at the transverse joint. Continue rolling along this line, shifting position gradually across the joint, in 6-to 8-inch (15 to 20 cm) increments, until the joint has been rolled by entire width of the roller wheel.
- E. Keep the number of transverse joints to a minimum. When paving single width and maintaining traffic, pave one lane no farther than one block. Complete all lanes to the same station at the end of each paving day. When paving in echelon, bring the lanes up even as is practical.

### 3.22 LONGITUDINAL JOINTS:

- A. Roll longitudinal joints directly behind the paving operation. Assure the first lane placed is true to line and grade and has a vertical face. Place the material in the lane being paved up firmly against the face of the previously placed lane. Position the paver during spreading to assure the material overlaps the edge of the lane previously placed by 1 inch to 2 inches (25 to 50 mm). Uniformly maintain the width and depth of the overlapped material at all times. Keep the paver aligned with the line or markings placed along the joint for alignment purposes. Before rolling, remove and dispose of the coarse aggregate in the material overlapping the joint.

- B. Shift rollers onto the previously placed lane so that not more than 6 inches (15 cm) of the roller wheel rides on the edge of the fine material left by brooming. Operate the rollers to compact the fines gradually across the joint. Continue rolling until a compacted, neat joint is obtained. When the abutting lane is not placed in the same day, paint the joint with a very thin coating of asphalt before placing the abutting lane. If the joint is distorted during the day's work by traffic or by other causes, carefully trim the edge of the lane to a neat line.

### 3.23 EDGES:

- A. Roll the pavement edges concurrently with or immediately after rolling the longitudinal joint.
- B. Exercise care in consolidating the course along the entire length of the edges. In rolling pavement edges, extend the roller wheels 2 to 4 inches (5 to 10 cm) beyond the pavement edge.

### 3.24 BREAKDOWN ROLLING:

- A. Immediately begin breakdown rolling following the rolling of the longitudinal joint and edges. Operate rollers as close to the paver as required to obtain density without causing undue displacement. Operate the breakdown roller with the drive roll or wheel nearest the finishing machine. The Engineer may make exceptions when working on steep slopes or super-elevated curves.

### 3.25 SECOND ROLLING:

- A. Assure the second rolling follows the breakdown rolling as close as possible while the paving mix is still at a temperature that will provide the specified density.

### 3.26 FINISH ROLLING:

- A. Perform the finish rolling while the material is still warm enough to remove roller marks. If necessary, the Engineer may require using pneumatic-tired rollers. Complete finish rolling the same day the mixture is placed.
- B. In places inaccessible to standard rollers, perform compaction using trench rollers or others to meet the specified compaction requirements. Operate the trench roller as directed until the course is compacted. Hand, manual or mechanical tamping, may be used in such areas if it is proved to the Engineer that the operation will provide the specified density.

### 3.27 SHOULDERS:

- A. Where paved shoulders or curbs are not specified, do not place the shoulder material against the pavement edges until the surface course rolling is completed.

Take care to prevent distortion of the pavement edge from specified line and grade. When shoulders are paved (except in conjunction with the traveled way paving), cold joint construction procedure is required to assure a tight bond at the joint.

- B. When the rolling of the surface course has been completed and the edges have been thoroughly compacted, immediately place shoulder material against the edges and roll it.

### 3.28 DENSITY AND SURFACE REQUIREMENTS:

- A. The average mat density shall be equal to or greater than 93 percent of the maximum density as determined by ASTM D2041 and no individual sample shall be less than 92 percent of maximum (Rice's) density, prepared as specified in Part 2-Products in this section and made from plant mix meeting the job-mix formula. Verification of maximum density as determined by ASTM D2041 from plant produced material during production is recommended.
- B. Produce a final surface that is uniform in texture and meets the line and grade specified. Before final acceptance of the Project or during the progress of the work, the Engineer will determine the thickness of all courses. Repair or replace all unsatisfactory work.
- C. Assure density and thickness meets the plans and specifications. During compaction, preliminary tests to aid in controlling the thickness, may be performed by inserting a flat blade, correctly graduated, through the material to the top of the previously placed base, or by other approved methods.
- D. In checking compacted depth, the cutting of the test holes, refilling with acceptable materials and proper compaction may be performed by the Owner's testing agency.
- E. For testing the surface on all courses, a 10-foot (3 m) straightedge will be used with the centerline of the straightedge placed parallel to the roadway centerline.
- F. Any variations that exceed 5/16-inch (0.8 cm) in 10 feet (3 m) for base course and 1/4-inch (0.64 cm) in 10 feet (3 m) for surface course must be corrected. Correct irregularities that may develop before the completion of rolling by loosening the surface mix and removing or adding materials as is required. If any irregularities or defects remain after the final compaction, remove the surface course and place and compact new material to a true and even surface. All minor surface projections, joints and minor honeycombed surfaces must be rolled smooth to grade, as directed.



- G. Remove and replace areas of new pavement requiring patching as directed. Patching material will be tested for meeting specifications. The cost of testing is at Contractor expense.

### 3.29 PAVEMENT AND MATERIAL TESTING REQUIREMENTS:

- A. Owner's testing agency will provide core samples of asphalt surface courses to check in place density and compacted depth. The cores are 4-inch (10 cm) diameter. Materials and acceptance tests will be made by the Owner's testing agency to determine the Contractor's compliance with the specifications.
- B. Materials failing to meet the tests specified may be retested if approved and as directed by the Engineer. The Contractor shall pay the costs of any required re-testing for acceptance purposes. Re-testing will be performed by the Owner's testing agency unless otherwise approved by the owner. . If there is a dispute, a third party testing firm may be retained by the contractor for additional retesting for the Engineer's review and consideration.
- C. The costs of the following tests are at Contractor expense:
  - 1. Initial aggregate quality tests
  - 2. Job-Mix Formula
  - 3. Any tests the Contractor requires to control his crushing, screening or other construction operations
  - 4. Retesting of failing tests as provided above
- D. Correct all pavement composition, field density, or thickness, deficiencies at Contractor expense.
- E. The field density and thickness of the pavement is determined by measuring the cores tested. The actual thickness must be no less than 1/4-inch (6.5 mm) from the specified thickness.
- F. When the measurement of any core is less than the plan thickness by more than the allowable deviation, the actual thickness of the pavement in this area may be determined by taking additional cores at intervals parallel to the centerline in each direction from the affected location. Continue in each direction until a core is found which is not deficient by more than the allowable deviation. The Engineer will evaluate areas found deficient in thickness and determine which areas warrant removal. Remove and replace the areas with asphaltic concrete of the thickness shown on the plans. Additional coring is considered as re-testing of failing areas.

**PART 4: MEASUREMENT AND PAYMENT**

**1. 1 PATCHING:**

- A. Patching is paid for at the contract unit price bid. Price and payment is full compensation for work and incidentals necessary to complete this item.

**END OF SECTION**

## **SECTION 02910**

### **SEEDING**

#### **PART 1: GENERAL**

##### **1.1 DESCRIPTION**

- A. This section includes ground surface preparation; furnishing and applying fertilizer; and furnishing and planting seed in areas described in the contract documents or directed by the Engineer.
- B. Hydraulic seeding is not included in this section. Hydraulic seeding is covered in Section 02920, Hydraulic Seeding.

##### **1.2 SUBMITTALS**

- A. Submit to the Engineer applicable seed mixture certifications, fertilizer descriptions and mulch certifications. Furnish duplicate signed copies of the vendors statement certifying that each seed lot has been tested by a recognized seed testing laboratory within 6 months of date of delivery. Assure the statement includes: Name and address of laboratory, date of test, lot number for each seed species and the test results including name, percentages of purity and of germination, percentage of weed content for each kind of seed furnished and, for seed mixes, the proportions of each kind of seed.

#### **PART 2: PRODUCTS**

##### **2.1 SEED**

- A. Furnish seed and seed mixture, free of all prohibited noxious weed seed or any other weed seed prohibited by state or local ordinance.
- B. Seal and label all seed containers to comply with Montana Seed Law and Regulations or meeting U.S. Department of Agriculture and Regulations under the Federal Seed Act, if shipped in interstate commerce.
- C. Do not use wet, moldy, or otherwise damaged seed in the work.
- D. Furnish seed mixture of the species described in the contract documents. Furnish seed in standard containers labeled with the seed name, lot number, net weight,

percentages of purity, germination, hard seed, and percentage of maximum weed seed content for each seed species.

## 2.2 TOPSOIL

- A. Use topsoil that is loose, friable, loamy soil, free of excess acid and alkali. Assure topsoil does not contain objectionable amounts of sod, hard lumps, gravel, sub-soil or other undesirable material that would form a poor seedbed. Before striping topsoil, assure it has supported the growth of healthy crops, grass or other vegetable growth.

## 2.3 LIME

- A. Furnish ground limestone or other material deemed suitable by the Engineer containing a minimum 85 percent of total carbonate equivalent ground so that 90 percent will pass through a No. 100 mesh sieve. Coarser material may be acceptable, if the application rates are increased to provide at least the minimum quantities and depth specified using an approved Dolomitic lime or a high magnesium lime containing at least 10 percent magnesium oxide.

## 2.4 FERTILIZER

- A. Furnish standard commercial fertilizers supplied separately or in mixtures containing the specified percentages of total nitrogen, available phosphoric acid, and water soluble potash. Apply fertilizer at the specified rate and depth meeting the applicable State and Federal laws. Furnish fertilizer in standard containers clearly labeled with name, weight, and guaranteed analysis of contents. No cyanamide compounds of hydrated lime are permitted in mixed fertilizers.
- B. Fertilizers may be supplied in one of the following forms:
  - 1. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
  - 2. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
  - 3. A granular or pellet form suitable for application by blower equipment.

## 2.5 SOILS FOR REPAIRS

- A. Use soil for filling and topsoiling repair areas of equal quality to the existing topsoil being repaired. Assure the soil is free of large stones, roots, stumps, or other

materials that interfere with sowing, compacting, and establishing turf. Obtain approval from the Engineer before placing topsoil.

### **PART 3: EXECUTION**

#### **3.1 TOPSOIL**

- A. Place at least 6 inches (15 cm) of topsoil in all areas to be seeded. Import topsoil if sufficient topsoil is not available from excavated areas of the project.

#### **3.2 ALLOWABLE SEEDING MONTHS**

- A. Perform seeding when the temperature and moisture are favorable to germination and plant growth. Seed preferably before June 1st and after October 1st of each year. Seeding dates must be approved by the Engineer.

#### **3.3 SEEDBED PREPARATION AND SOWING**

- A. Clear the areas to be seeded of all debris, vegetation, and other material determined by the Engineer to be detrimental to the preparation of a seedbed. Once the area is cleared, disc, harrow, rake, or work the area by other suitable methods, into a smooth, even seedbed. Assure the prepared seedbed surface is firm enough to prevent seed loss from high winds or normal rainfall. If rolling is required, perform rolling before seeding using a suitable roller, of a weight appropriate to the soil conditions.
- B. Sow seed in the areas described in the contract documents at the specified application rates.
- C. Sow seed using a force feed drill having a grass seed attachment, except of slopes steeper than three to one or on areas too small to be seeded with a force feed drill. In these areas, seed may be sown by power sprayers, blowers or other effective methods. Use equipment in good working order.
- D. Seed specified mix at a depth specified by manufacturer and cultipack the seed.
- E. Do not sow seed in winds that prevent proper imbedment into the surface.

### 3.4 FERTILIZER

- A. Spread and work fertilizer into the soil during the final seedbed preparation. Apply fertilizer at the rate described in the contract documents.

### 3.5 CARE OF SEEDED AREAS

- A. Keep the seeded area moist until it has germinated and it's continued growth is assured. Prevent erosion during watering. Water is incidental to the item "Seeding".
- B. Protect all seeded areas from traffic or pedestrian use with warning barricades or other Engineer approved methods.
- C. Maintain the seeded area, performing any required watering and mowing until the seed is firmly established. Prevent weeds and other undesirable vegetation from establishing in the seeded area. Mow weeds and rake and remove the clippings from the areas.
- D. Replace any seeded areas failing to germinate which have died or been damaged by construction activities. Replace such areas to meet the contract requirements. The contract warranty period applies to this item.

## **PART 4: MEASUREMENT AND PAYMENT**

### 4.1 GENERAL

- A. Seeding shall cover all disturbed soils excluding areas to be paved or graveled and paid for as part of the lineal feet of trenched / installed conduit unit price bid including topsoil salvage and/or importing, topsoil placement, seedbed preparation, and seeding, complete in place and accepted by the Engineer.
- B. Payment indicated to include complete compensation for all labor, equipment, materials and incidentals required for the completion of the work.

### **END OF SECTION**

## **SECTION 260000 – ELECTRICAL GENERAL REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 ELECTRICAL REQUIREMENTS**

- A. The electrical requirements are supplemental to the General and Supplementary Conditions and the General Requirements of these Specifications. The Electrical Sections shall apply to phases of the work specified, shown on the Drawings, or required to provide for the complete installation of Electrical Systems for this project.
- B. The work shall include all items, articles, materials, operations and methods listed, mentioned or scheduled in these specifications and the accompanying drawings. All material, equipment and labor shall be furnished together with all incidental items required by good practice to provide the complete systems described.
- C. Examine and refer to all Architectural, Structural, Utility, Landscape, and Mechanical drawings and specifications for construction conditions which may affect the electrical work. Inspect the building site and existing facilities for verification of present conditions. Make proper provisions for these conditions in performance of the work and cost thereof.
- D. See general requirements for listed Alternate Bids. Note alternates listed and include any changes in work and price required to meet the requirements of the respective alternate.

#### **1.2 CODES AND STANDARDS**

- A. Work shall meet the requirements of the plans and specifications and shall not be less than the minimum requirements of applicable sections of the latest Codes and Standards of the following organizations:

American National Standards Institute (ANSI)  
Americans with Disabilities Act (ADA)  
Certified Ballast Manufacturers (CBM)  
Electrical Testing Laboratories (ETL)  
Independent Testing Laboratories (ITL)  
National Electrical Code (NEC) Latest Edition  
National Electrical Manufacturers Association (NEMA)  
National Fire Protection Association (NFPA)  
Occupational Safety & Health Act (OSHA)  
Underwriters Laboratories (UL)  
Uniform Building Code (UBC)  
Rules and Regulations of the State Fire Marshal  
Requirements of the Serving Utility Company  
Local and State Codes and Ordinances

#### **1.3 FEES AND PERMITS**

- A. The electrical contractor shall pay all fees and arrange for all permits required for work done under his contract and under his supervision by subcontract.

#### 1.4 MATERIALS AND EQUIPMENT

- A. Manufacturer's trade names and catalog numbers listed are intended to indicate the quality of equipment or materials desired. Manufacturers not listed must have prior approval. Written prior approval must be obtained from the Architect/Engineer ten (10) days prior to bid opening. Requests are to be submitted sufficiently ahead of the deadline to give ample time for examination. The items approved will be listed in an addendum and only this list of equipment will be accepted in lieu of specified products. Submittals must indicate the specific item or items to be furnished in lieu of those specified, together with complete technical and comparative data on specified items and proposed items.
- B. Electrical equipment may be installed with manufacturers' standard finish and color except where specific color, finish or choice is indicated. If the manufacturer has no standard finish, equipment shall have a prime coat and two finish coats of architect approved enamel.
- C. This contractor shall be responsible for materials and equipment installed under this contract. Contractor shall also be responsible for the protection of materials and equipment of others from damage as a result of his work.
- D. Manufactured material and equipment applied, installed, connected, erected, used, cleaned and conditioned as directed by manufacturer unless herein specified to the contrary.
- E. This contractor shall make the required arrangement with General Contractor for the introduction into the building of equipment too large to pass through finished openings.
- F. Store materials and equipment indoors at the job site or, if these are not possible, stores on raised platforms and protect from the weather by means of waterproof covers. Coverings shall permit circulation of air around the materials to prevent condensation of moisture. Screen or cap openings to prevent the entry of vermin.
- G. Lighting fixtures proposed, as substitutes to those specified must have prior approval by Architect/Engineer as noted above. Approval will not be considered unless the request has all of the following information:
  - 1. Manufacturers data showing catalog number.
  - 2. Construction details.
  - 3. Photometrics.
  - 4. Recommended maintenance factor.

#### 1.5 INTENT OF DRAWINGS

- A. The drawings are partly diagrammatic and do not necessarily show exact location of conduit unless specifically dimensioned. Riser and other diagrams are schematic and do not



necessarily show the physical arrangement of the equipment. They shall not be used for obtaining quantities or lineal runs of conduit.

- B. The Contractor shall visit the site prior to the bid and examine all existing conditions. Discrepancies shown on different plans or between plans and actual field conditions shall be brought to the attention of the Architect/Engineer for resolution prior to the bid.
- C. The plans and specifications go hand in hand. What is required in one is to be considered as required by both contract documents. If a conflict exists between the plans and the specifications the most stringent requirement of the two shall be interpreted as the intent of the documents.

#### 1.6 RESPONSIBILITY

- A. Be responsible for the installation of a satisfactory and complete system in accordance with the intent of the drawing and specifications. Provide, at no extra cost, all incidental items required for completion of the work even though they are not specifically mentioned or indicated on the drawings or in the specifications.
- B. The drawings do not attempt to show complete details of construction which affect the electrical installation; and reference is therefore required to the Architectural, Structural, Landscape and Civil drawings and specifications and to shop drawings of all trades for additional details which affect the installation of the work covered under this Division of the Contract.
- C. Location of electrical system components shall be checked for conflicts with openings, structural members and components of other systems having fixed locations. In the event of any conflicts, the Architect/Engineer shall be consulted and his decision shall govern. Necessary changes shall be made at no additional expense to the Architect/Engineer or Owner.
- D. Determine, and be responsible for, the proper location and character of inserts for hangers, chases, sleeves and other openings in the construction required for the work, and obtain this information well in advance of the construction progress so work will not be delayed. Roughing-in fixtures, etc. must be laid out accurately. Connections to equipment of the same class shall be equal heights, plumb, and at right angles to the wall, unless otherwise directed.
- E. Final location of inserts, hangers, etc., required for each installation, must be coordinated with facilities required for other installations to prevent interference.
- F. Take extreme caution not to install work that connects to equipment until such time as complete Shop Drawings of such equipment have been approved by the Architect/Engineer. Any work installed by the Contractor, prior to approval of Shop Drawings, will be at the Contractor's risk.
- G. At all times during the performance of this Contract, properly protect work from damage and protect the Owner's property from injury or loss. Make good any damage injury or loss,

except such as may be directly due to errors in the Bidding Documents or caused by Agents or Employees of the Owner. Adequately protect adjacent property as provided by law and the Bidding Documents. Provide and maintain passageways, guard fences, lights and other facilities for protection required by Public Authority or Local conditions.

- H. Circuiting and switching shall be exactly as shown on drawings. Combining of home runs is acceptable but no more than three different phase, one neutral, one equipment ground and associated light switch conductors shall be installed in any single raceway except where specifically noted otherwise on the plans. Three phase branch circuits, where applicable, shall each be individually home run in a separate raceway. Contractor shall refer to NEC Article 310.8 and adjust accordingly. Combining of wiring of various systems in conduit runs is not acceptable unless otherwise specified herein or noted on drawings.

#### 1.7 INSPECTION

- A. All work and material is subject to inspection at any time by the Architect/Engineer or his representative. If the Architect/Engineer or his representative finds material that does not conform with these specifications or that is not properly installed or finished, correct the deficiencies in a manner satisfactory to the Architect/Engineer at no additional expense to the Owner.

#### 1.8 WORKMANSHIP

##### A. GENERAL

- 1. Work under this contract shall be performed by workmen skilled in the particular trade including work necessary to properly complete the installation in a workmanlike manner to present a neat and finished appearance.

##### B. EXCAVATION AND BACKFILL

- 1. Provide all excavating and backfilling as required, with backfilling only after approval of the Engineer. Backfill shall be free of all debris and decayable matter. See Excavation and Backfill requirements in DIVISION 1 -- GENERAL REQUIREMENTS.

##### C. CUTTING, PATCHING AND FRAMING

- 1. Obtain Architect's/Engineer's approval before performing any cutting on structural members or patching of building surfaces. Any damage to the building or equipment by this Contractor shall be the responsibility of this Contractor and shall be repaired by skilled craftsmen of the trades involved at no additional expense to the Owner.
- 2. Chases, openings, sleeves, hangers, anchors, recesses, equipment pads, framing for equipment, provided by others only if so noted on the drawings. Otherwise, they will be provided by this contractor for his work. Whether chases, etc., are provided by this contractor or others, this contractor is responsible for correct size and locations.

## 1.9 COORDINATION

- A. This contractor shall plan his work to proceed with a minimum interference with other trades and it shall be his responsibility to inform the General Contractor of all openings required in the building structure for installation of work, and to provide sleeves as required. Dimensions of equipment installed and/or provided by others shall be checked in order that correct clearances and connections may be made.

## 1.10 CLEAN UP

- A. Keep the premises free from accumulation of waste material or rubbish caused by his work or employees.
- B. Upon completion of work, remove materials, scraps and debris relative to his work and leave the premises, including tunnels, crawl spaces, and pipe chases in clean and orderly condition. Remove all dirt and debris from the interior and exterior of all devices and equipment. After construction is completed, wash all light fixtures and lamps, remove all labels from fixture lenses.

## 1.11 DUST PROTECTION

- A. Contractor will provide suitable dust protection for all existing areas prior to beginning of cutting or demolition. Contractor will obtain approval of partition from Owner before proceeding with work involved in these rooms.

## 1.12 TEMPORARY FACILITIES

### A. OFFICES

- 1. Contractor shall provide temporary offices for himself including lights, heat and telephone, if required.

### B. REMOVAL

- 1. Contractor shall completely remove his temporary installations when no longer needed and the premises shall be completely clean, disinfected, patched, and refinished to match adjacent areas.

### C. LADDERS AND SCAFFOLDS

- 1. The contractor shall provide their own ladders, scaffolds, etc. of substantial construction for access to their work in various portions of the building as may be required. When no longer needed, they shall be removed by the contractor.

### D. PROTECTION DEVICES

1. The contractor shall provide and maintain his own necessary barricades, fences, signal lights, etc. required by all governing authorities or shown on the drawings. When no longer needed, they shall be removed by the contractor. The contractor shall assume all responsibility for which the owner may be held responsible because of lack of above items.

E. TEMPORARY WATER

1. The contractor shall provide all water required by his trade for construction. Temporary drinking water shall be provided by contractor from a proven safe source dispensed by single service containers, until such time as the construction water outlet has been install, disinfected and approved for drinking purposes.

F. TEMPORARY FIRE PROTECTION

1. The contractor shall provide all necessary first-aid hand fire extinguishers for Class A, B, C and special hazards as may exist in his own work area only in accordance with good and safe practice and as required by jurisdictional safety authority. The contractor shall provide general area fire extinguishers only.

1.13 TEMPORARY ELECTRICAL FACILITIES

A. DESCRIPTION OF SYSTEM

1. Service required- The contractor shall provide and connect movable temporary panels to a temporary distribution board as necessary. The temporary panels shall be located as directed by the Owner/Engineer. Each panel shall have provisions for 100 amps at the voltage and phase available.
2. Provide temporary electric power for items listed, throughout the construction period, so that power can be secured at any desired point from temporary service panel within the construction area.
  - a. Power centers for miscellaneous tools and equipment used in the construction period, so that power can be secured at any desired point from temporary service panel within the construction area.
  - b. Provide lighting for safe and adequate working conditions throughout the site and within the buildings. Provide at least 1/2 watt of incandescent lighting per square foot of floor area. Maintain a socket voltage of at least 110 volts. Use a minimum of 100-watt bulbs.
  - c. Power for construction site offices and for other temporary storage and construction buildings.
  - d. Power to maintain continuous construction during changeover of electrical equipment.

- e. Power for testing and checking equipment.

B. CAPACITY

- 1. Provide and maintain adequate electrical power for construction use by all trades during the construction period at the locations necessary.
- 2. Notify the Serving Utility Company when unusually heavy loads will be connected.

C. POWER COSTS

- 1. The contractor shall pay all cost of setting and removing temporary service.

D. USE OF PERMANENT SYSTEM

- 1. Regulate any part of the permanent electrical system which is used for construction purposes to prevent interference with safety and orderly progress of the work.
- 2. Leave permanent electrical services in a condition as good as new.

1.14 SHOP DRAWINGS

- A. Provide an ELECTRONIC copy of manufacturer's literature and/or certified prints as soon as possible but within thirty (30) days after awarding of Contract, for items of materials, equipment, or systems where called for in specifications. Shop drawings and literature shall be complete, showing item used, size, dimensions, capacity, rough in, etc., as required for complete check and installation. Manufacturers literature showing more than one item shall be clearly marked as to which item is being furnished or it will be rejected and returned without review.
- C. Each copy of each item submitted must be clearly marked as follows for purposes of identification and record. Submittals not marked (typewritten only) as described below will be rejected and returned without review.

Date:  
Name of Project:  
Branch of Work:  
Submitted by:  
Specification or Plan Reference:

- C. Prior to their submission, each submittal shall be thoroughly checked by the contractor for compliance with the Contract Document requirements, accuracy of dimensions, relationship to the work of other trades, and conformance with sound, safe practices as to erection and installation. Each submittal shall then bear a stamp evidencing such checking and shall show corrections made, if any. Submittals requiring extensive corrections shall be revised before submission. Each submittal not stamped and signed by the contractor evidencing such checking will be rejected and returned without review.

- D. All submittals will be examined when submitted in proper form for compliance. Such review shall not relieve the contractor of responsibility for errors, for deviation from the contract Documents, nor for violation of sound safety practices.
- E. The contractor shall keep in the field office one print of each submittal, which has been reviewed and stamped by the Architect or Engineer.
- F. Submittals will be required for each item of material and equipment furnished as noted in specifications.
- G. Submittals which are incomplete relative to quality requirements, capacity, engineering data, dimensional data or detailed list of specialty or control equipment will be rejected. Lists shall include descriptive coding as specified or shown on drawings.
- H. Schedule of Shop Drawings.

ITEM	MFG LIT	SHOP DWG	WIRING DIAG.	O&M BOOK
RACEWAYS AND FITTINGS	X			
WIRE AND CABLE	X			
DISTRIBUTION PANELS AND PEDESTALS	X	X		
LIGHT FIXTURES	X	X		

#### 1.15 OPERATION AND MAINTENANCE MANUALS

- A. At the time orders are placed for any item of equipment requiring service or operating maintenance, the contractor shall request the manufacturer furnish three (3) copies of OPERATION AND MAINTENANCE INSTRUCTIONS for each piece of equipment. These shall be included in the brochure of equipment.

#### 1.16 BROCHURE OF EQUIPMENT

- A. Upon completion of work, prepare a "Brochure of Equipment" containing data pertinent to equipment and systems on job. Binders containing materials shall be one or more three ring binders of sufficient number to hold all literature. Contained in binders shall be: Installation, maintenance, and operating instructions for each piece of equipment; parts lists; wiring diagrams; one copy of each shop drawing and literature submittal; record drawings, etc.
- B. All literature shall be clean, unused and filed under divider headings corresponding to the specifications.

- C. These brochures shall be submitted to the Architect/Engineer and approved by him before authorization of final payment.

#### 1.17 "RECORD" DRAWINGS

- A. The contractor shall furnish to the Owner and Architect/Engineer a red line marked print set of drawings, each sheet stamped as the "As-Built" drawing and bearing the contractor's name, date and signature. The As-Built drawing shall show the location of all concealed or underground conduit runs and other equipment, devices, outlets, etc., installed other than as shown on the drawings. Dimension underground lines from established building lines. As-Built drawings to be developed from a job site record drawing set and shall be clean, neat and all changes legible and shown in the same format and symbols used on the contract drawings. The As-Built drawing set shall be submitted to the architect/engineer for approval, and any deficiencies noted by the architect/engineer corrected and resubmitted until approved by the architect/engineer at no cost to architect/engineer or owner.

#### 1.18 PLACING SYSTEMS IN OPERATION

- A. At the completion of the work and at such time as the Owner shall direct, prior to final acceptance, the contractor performing this work shall put into satisfactory operation the various systems installed under the specifications. At no additional cost to the Owner, furnish the services of a person completely familiar with the installations performed under this specification, to instruct the Owners operating personnel in the proper operation and servicing of the equipment and systems. These services shall be available for a period of no less than one (1) day.

#### 1.19 GUARANTEE-WARRANTY

- A. This contractor shall and hereby does warrant and guarantee that all work executed under this Division will be free from defects of materials and workmanship for a period of one year from the date of final acceptance of this work and that he will, at his own expense, repair and/or replace all such defective materials and work and all other work damaged thereby which becomes defective during the term of warranty, except that lamps and tubes shall be his responsibility only for normal lamp life or one year, whichever occurs first.

END OF SECTION 260000

## **SECTION 260521 - CONDUCTORS AND CABLES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

#### **1.2 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

### **PART 2 - PRODUCTS**

#### **2.1 CONDUCTORS AND CABLES**

- A. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- B. Conductor Material: Solid conductor for #10 AWG and smaller, stranded for #8 AWG and larger. Copper shall be 98 percent conductivity and hard drawn.
  - 1. Aluminum conductors shall be permitted for feeders of 100 Amps or larger, or as indicated on the plans.
- C. Conductor Insulation Types: Type THHN-THWN, XHHW, or XHHW-2 complying with NEMA WC 5.

#### **2.2 CONNECTORS AND SPLICES**

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

### **PART 3 - EXECUTION**

#### **3.1 CONDUCTOR AND INSULATION APPLICATIONS**



- A. Service Entrance: Type XHHW or XHHW-2 single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- H. Underground Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.
- I. Neutral Conductor: Where a secondary distribution system requires a neutral conductor, a full-sized neutral conductor shall be used throughout the system, such that that neutral conductor is not shared with any other branch circuit or feeder. If the secondary distribution system supports computers or other equipment that generates harmonics, double size neutrals shall be run from the subpanel boards feeding this equipment back to the MDP or service entrance. Neutral buses shall be sized to accommodate these conductors. Insulated equipment grounding conductors run with branch circuits shall be installed such that that conductor is not shared with any other branch circuit.

### 3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Raceways and Boxes."
- F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

- G. Identify and color-code conductors and cables according to Division 26 Section “Electrical Identification.”

### 3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
  - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12” of slack.

### 3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
  - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

END OF SECTION 260521

## **SECTION 260526 - GROUNDING AND BONDING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. Standards and Code References:
  - 1. NFPA 70 – National Electrical Code

#### **1.2 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  - 1. Comply with UL 467.
- B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

### **PART 2 - PRODUCTS**

#### **2.1 GROUNDING CONDUCTORS**

- A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
- B. Material: Aluminum, copper-clad aluminum, and copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Stranded copper cable.
- F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

H. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch (6.4 mm) in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

I. Ground Conductor and Conductor Protector for Wood Poles: As follows:

1. No. 3 AWG minimum, soft-drawn copper conductor.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.

J. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators as shown on drawings.

## 2.2 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.
- B. Ground Rods
  1. Size: 5/8" diameter by 8 feet long.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment-grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.
- F. Grounding Bus: Install in electrical room and in rooms housing service equipment, and elsewhere as indicated.
  - 1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
  - 2. At doors, route the bus up to the top of the doorframe, across the top of the doorway, and down to the specified height above the floor.

### 3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Flexible raceway runs.
  - 5. Armored and metal-clad cable runs.
- D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

- F. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for communications cables.

### 3.3 INSTALLATION

- A. Ground Rods: At the service entrance location, install at least two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
  - 1. Drive ground rods until tops are 2" below finished floor or final grade, unless otherwise indicated.
  - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

### 3.5 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surface indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For #12 AWG and larger, use pressure-type grounding lugs. #12 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### 3.6 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
  - 1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
  - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
  - 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Maximum value of ground resistance is 25 ohms.
  - 4. Excessive Ground Resistance: If resistance to ground exceeds specified values, drive additional ground rods until resistance meets specified values.

END OF SECTION 260526

## **SECTION 260533 - RACEWAYS AND BOXES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

#### **1.2 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. RMC: Rigid metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible nonmetallic conduit.
- G. RNC: Rigid nonmetallic conduit.

#### **1.3 SUBMITTALS**

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.
  - 1. Detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
  - 1. Ceiling suspension assembly members.
  - 2. Method of attaching hangers to building structure.
  - 3. Size and location of initial access modules for acoustical tile.
  - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.



#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

#### 1.5 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, and partition assemblies.

### **PART 2 - PRODUCTS**

#### 2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- C. Plastic-Coated IMC and Fittings: NEMA RN 1.
- D. EMT and Fittings: ANSI C80.3.
  - 1. Fittings: Compression type. Set screw type not permitted.
  - 2. Connectors: Threaded / locknut type. Snap in type not permitted.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

#### 2.2 NONMETALLIC CONDUIT AND TUBING

- A. ENT: NEMA TC 13.
- B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
- C. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
- D. LFNC: UL 1660.

## 2.3 METAL WIREWAYS

- A. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or NEMA 3R.
- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- D. Wireway Covers: Hinged type or as indicated.
- E. Finish: Manufacturer's standard enamel finish.

## 2.4 NONMETALLIC WIREWAYS

- A. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- B. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

## 2.5 SURFACE RACEWAYS

- A. Above-Ground Raceways: Rigid galvanized steel conduit, intermediate metal conduit and corrosion-treated electrical metallic tubing shall be used as permitted by codes for above-ground installations and for wiring in non-hazardous areas of buildings. Aluminum and PVC conduit may be used only with the approval of DE/EEB in limited applications. Raceway installation in the ceiling space is preferred over installation in floor slabs.
- B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.
- C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- D. Floor Boxes: Cast metal, fully adjustable, rectangular.
- E. Floor Boxes: Nonmetallic, nonadjustable, round.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- I. Cabinets: NEMA 250, Type 12, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover. Key latch as indicated. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

## 2.7 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

## PART 3 - EXECUTION

- 3.1 STC Rating: All installations of raceway and conduit shall be done in a manner that will maintain the STC rating of the walls.

## 3.2 RACEWAY APPLICATION

- A. Outdoors:
  - 1. Exposed: Rigid steel.
  - 2. Concealed: Rigid steel.

3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R.

B. Indoors:

1. Exposed: EMT Conduits may be exposed in utility spaces such as electrical and mechanical rooms only by written approval from the engineer.
2. Concealed: EMT.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
4. Damp or Wet Locations: Rigid steel conduit.
5. Boxes and Enclosures: NEMA 250, Type 12, except as follows:
  - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
6. Lighting fixtures “whips”: FMC or MC cable.

C. Minimum Raceway Size:  $\frac{3}{4}$ ". Exception:  $\frac{1}{2}$ " as noted for specialized control conduits.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
3. Use only compression type fittings on EMT; use of set screw fittings on EMT is not permitted.

E. Do not install aluminum conduits embedded in or in contact with concrete.

### 3.3 INSTALLATION

- A. Keep raceways at least 6" away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Install temporary closures to prevent foreign matter from entering raceways.
- C. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- D. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

- E. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
  - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- F. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2" of concrete cover.
  - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
  - 2. Space raceways laterally to prevent voids in concrete.
  - 3. Run conduit larger than 1" parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  - 4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, or rigid steel conduit, before rising above the floor.
- G. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
  - 1. Run parallel or banked raceways together on common supports.
  - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- H. Join raceways with fittings designed and approved for that purpose and make joints tight.
  - 1. Use insulating bushings to protect conductors.
- I. Terminations:
  - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
  - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 90-kg tensile strength. Leave at least 12" of slack at each end of pull wire tied off with 1" locknut.
- K. Telephone and Signal System Raceways, 53 and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements. Pull or junction boxes shall not be used as a bend.

- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces and from conditioned to non-conditioned spaces.
  - 2. Where otherwise required by NFPA 70.
- M. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC or LFMC may be used 150 mm above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- N. Flexible Connections: Use maximum of 1830 mm of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- O. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- P. Set floor boxes level and flush with finished floor surface.
- Q. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- R. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

### 3.4 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

### 3.5 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 260533

## **SECTION 260553 - ELECTRICAL IDENTIFICATION**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

#### **1.2 QUALITY ASSURANCE**

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

#### **1.3 COORDINATION**

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

### **PART 2 - PRODUCTS**

#### **2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
  - 1. Power Circuits: Black letters on an orange field.
  - 2. Legend: Indicate system or service and voltage, if applicable.

- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 50 mm (2 inches) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 50 mm (2 inches) wide; compounded for outdoor use.

## 2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 0.08 mm (3 inches) thick by 25 to 50 mm (1 to 2 inches) wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.35-mm (0.014-inch) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or aluminum, 50 by 50 by 1.3 mm (2 by 2 by 0.05 inch), with stamped legend, punched for use with self-locking nylon tie fastener.
- E. Write-On Tags: Polyester tag, 0.38 mm (0.015 inch) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

## 2.3 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
  - 1. Not less than 150 mm (6 inches) wide by 0.102 mm (4 mils) thick.
  - 2. Compounded for permanent direct-burial service.
  - 3. Embedded continuous metallic strip or core.
  - 4. Printed legend shall indicate type of underground line.



## 2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 1-mm (0.0396-inch) galvanized-steel backing; and with colors, legend, and size required for application. 6.4-mm (1/4-inch) grommets in corners for mounting. Nominal size, 250 by 360 mm (10 by 14 inches).
- C. Warning label and sign shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET."

## 2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1.6 mm (1/16 inch) thick for signs up to. 129 sq. cm (20 sq. in) and 3.2 mm (1/8 inch) thick for larger sizes.
  - 1. Engraved legend with black letters on white face.
  - 2. Punched or drilled for mechanical fasteners.
  - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Labels are not permitted.
- B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 10 mm (3/8 inch). Labels shall be mechanically fastened. Adhesive labels are not acceptable.
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 25 mm (1 inch).

## 2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
  - 1. Minimum Width: 5 mm (3/16 inch).
  - 2. Tensile Strength: 22.6 kg (50 lb), minimum.
  - 3. Temperature Range: Minus 40 to plus 85 deg C (Minus 40 to plus 185 deg F).
  - 4. Color: Black, except where used for color-coding.

- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## **PART 3 - EXECUTION**

### **3.1 APPLICATION**

- A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 100-mm (4-inch) wide black stripes on 250-mm (10-inch) centers over orange background that extends full length of raceway or duct and is 300 mm (12 inches) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 75-mm (3-inch) high black letters on 500-mm (20-inch) centers. Stop stripes at legends. Apply to the following finished surfaces:
  - 1. Floor surface directly above conduits running beneath and within 300 mm (12 inches) of a floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to raceways concealed within wall.
  - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 50 mm (2 inches) high, with snap-around labels. Repeat legend at 3-m (10-foot) maximum intervals.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange snap-around label.
- D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
  - 1. Fire Alarm System: Red.
  - 2. Fire-Suppression Supervisory and Control System: Red and yellow.
  - 3. Combined Fire Alarm and Security System: Red and blue.
  - 4. Security System: Blue and yellow.
  - 5. Mechanical and Electrical Supervisory System: Green and blue.
  - 6. Telecommunication System: Green and yellow.
  - 7. Control Wiring: Green and red.
- E. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use metal tags. Identify each ungrounded conductor according to source and circuit number.

- G. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
  - 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections.
  - 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- K. Instruction Signs:
  - 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
  - 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 10-mm (3/8-inch) high letters for emergency instructions at equipment used for power transfer and load shedding.
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 13-mm (1/2-inch) high letters on 38-mm (1-1/2-inch) high label; where 2 lines of text are required, use labels 50 mm (2 inches) high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

- a. Panelboards, electrical cabinets, and enclosures.
- b. Access doors and panels for concealed electrical items.
- c. Electrical switchgear and switchboards.
- d. Transformers.
- e. Emergency system boxes and enclosures.
- f. Disconnect switches.
- g. Enclosed circuit breakers.
- h. Motor starters.
- i. Push-button stations.
- j. Contactors.
- k. Remote-controlled switches, dimmer modules, and control devices.
- l. Voice and data cable terminal equipment.
- m. Fire-alarm control panel and annunciators.
- n. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
- o. Monitoring and control equipment.
- p. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

### 3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

- F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Color-Coding for Phase Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
  - 1. Color shall be factory applied.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 150 mm (6 inches) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- H. Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 150 to 200 mm (6 to 8 inches) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 400 mm (16 inches) overall.

END OF SECTION 260553

## **SECTION 262416 - PANELBOARDS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
  - 1. Distribution panelboards.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
- C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

#### **1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

#### **1.5 COORDINATION**

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment,

raceways, piping, and encumbrances to workspace clearance requirements.

## 1.6 EXTRA MATERIALS

- A. Keys: two spares of each type of panelboard cabinet lock.

## PART 2 - PRODUCTS

### 2.1 FABRICATION AND FEATURES

- A. Enclosures: Flush- and surface mounted cabinets. NEMA PB 1, Type 3R, to meet environmental conditions at installed location.
- B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
- E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.
- F. Bus: Tin-plated aluminum.
- G. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.
- H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- I. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- J. Gutter Barrier: Arrange to isolate individual panel sections.

### 2.2 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Mount breakers in all panelboards so that breaker handles operate in a horizontal plane (bolt-type only). Provide common trip on all multiple pole breakers.
  - 2. Where noted, provide spare breakers, complete for future connection of wiring circuits. Where "SPACE" or "PROV" is indicated for breakers, provide all bussing and breaker mounting hardware in the panelboard; provide steel knockouts in dead front metal closure of unused part of panel. If any steel knockouts are removed, provide breakers in such spaces or approved cover plates. Open spaces are not permitted.
- B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.
  - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
  - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
  - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim 72 inches above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts



uniformly flush with wall finish.

- D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Provide a type written circuit directory card for each panelboard with the load name, number, and location.
- E. Install filler plates in unused spaces.
- F. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- G. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

### 3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

### 3.3 CONNECTIONS

- A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
  - 1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

- C. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:
  - 1. Measure as directed during period of normal system loading.
  - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.
  - 3. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

### 3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

### 3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416

## **SECTION 262813 - OVERCURRENT PROTECTIVE DEVICES**

### **PART 1 GENERAL**

#### **1.1 DESCRIPTION OF WORK:**

- A. This section covers the furnishing and installation of all fuses and circuit breakers used in this project.

#### **1.2 STANDARDS AND CODES:**

- A. All materials and equipment specified herein shall, within the scope of UL Examination Services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label.
- B. All materials and equipment specified herein shall conform with all applicable NEMA, ANSI, and IEEE standards.
- C. All materials and equipment specified herein and their installation methods shall conform to the latest published version of the National Electric Code.
- D. All materials shall conform to the National Electrical Code Article 110-14C. Wiring and circuit breakers on this project are designed for 75 degree C operation above 30 amperes, 60 degrees C for 30 amperes and below.

#### **1.3 SUBMITTALS:**

- A. In accordance to the submittal requirements in section 260000, submit the catalog data showing material information and conformance with specifications. The intended use of each item shall be indicated.

### **PART2 PRODUCTS**

#### **2.1 FUSES:**

- A. Fuses shall be of the type and amperage indicated on the drawings. The voltage rating shall be appropriate for the application indicated. The fuse types indicated on the drawings imply a certain set of fuse characteristics. No substitutions of fuse types will be allowed without written approval from the Engineer. All fuses used on the project shall be provided with "blown fuse" indicators.
- B. Where fuses in motor circuits are indicated but not sized, provide Manufacturer's recommended fuse size based on actual motor installed.
- C. Provide in-line or integrally-mounted fuse clips on control power or low-voltage transformers.

D. Provide a minimum of two spare fuses for each fuse used.

E. Acceptable Manufacturers:

1. BUSSMAN
2. FERRAZ SHAWMUT
3. LITTLEFUSE
4. RELIANCE

## 2.2 MOLDED CASE CIRCUIT BREAKERS:

A. Molded case circuit breakers shall be quick-make and quick-break type. They shall have wiping type contacts. Each shall be provided with arc chutes and individual trip mechanisms on each pole consisting of both thermal and magnetic trip elements. Two and three pole breakers shall be common trip. All breakers shall be calibrated for operation in an ambient temperature of 40 degrees C. Molded case circuit breakers shall be trip-free. Each breaker shall have trip indication independent of the ON or OFF positions.

B. Breakers shall have lugs UL listed for both copper and aluminum.

C. Circuit breakers shall be capable of accepting the cable shown on the drawings. Circuit breakers that are not capable of accepting the cable shown shall not be acceptable. The Contractor shall contact the Engineer regarding any discrepancies.

D. Breakers shall have the interrupting rating and trip rating indicated on the drawings.

## 2.3 USES:

A. Breakers covered under this specification may be installed in switchboards, panelboards, motor control centers, combination motor starters and individual enclosures.

## 2.4 ENCLOSURES:

A. Unless otherwise shown on the drawings, enclosures for protective devices shall be NEMA rated for the environment in which they are installed. In general, devices installed indoors shall be in NEMA 12 enclosures. Devices installed outdoors shall be in NEMA 3R enclosures.

# PART 3 EXECUTION

## 3.1 INSTALLATION:

A. Fuses and circuit breakers shall be installed in their respective enclosures and located in such a manner as to ensure tight connections, so as to preclude arcing and overheating.

B. Install fuses so that their fuse rating is readable.

END OF SECTION 262813

## **SECTION 263200 - ELECTRICAL UTILITY SERVICES**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section includes arrangement with Utility Company for permanent electric service; payment of Utility Company charges for service; service provisions; and utility metering equipment

#### **1.2 REFERENCES**

#### **1.3 SYSTEM DESCRIPTION**

- A. Utility Company: FLATHEAD ELECTRIC.
- B. System Characteristics:
  - 1. Logan State Park: 120/240 Volts, single-phase, three-wire, 60 Hertz.
- C. Service Entrance: Underground

#### **1.4 SUBMITTALS**

- A. Section 260000 - Submittal Procedures: Submittal procedures.
- B. Submit Utility-Company-prepared drawings.

#### **1.5 QUALITY ASSURANCE**

- A. Perform Work in accordance with Utility Company written requirements.
- B. Maintain one copy of each document on site.

#### **1.6 FIELD MEASUREMENTS**

- A. Verify field measurements are as indicated on Drawings.

#### **1.7 COORDINATION**

- A. Coordinate with utility company, relocation of overhead or underground lines interfering with construction. Where power lines are to be relocated, bill utility costs, directly to Owner.
- B. Utility charges for service installation will be paid by the Contractor and are considered part of this contract.

## PART 2 PRODUCTS

### 2.1 UTILITY METERS

- A. A new meter for the new service drop shall be provided by the local utility company.

### 2.2 UTILITY METER BASE AND CURRENT TRANSFORMER CABINET

- A. Furnished and installed by electrical contractor per utility company standards.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify service equipment is ready to be connected and energized.

### 3.2 INSTALLATION

- A. Install secondary service entrance conduits between the utility transformer and the park service entrance equipment. The Utility Company will furnish, install, and connect the service entrance conductors from the transformer to the meter-main.

END OF SECTION 263200

## **SECTION 265100 - LIGHTING**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION OF WORK:**

- A. This section covers furnishing and installation of all light fixtures and lamps indicated on the drawings or specified herein.

#### **1.2 STANDARDS AND CODES:**

- A. All materials and equipment specified herein shall, within the scope of UL Examination Services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label.
- B. All materials and equipment specified herein shall conform with all applicable NEMA, ANSI, and IEEE standards.
- C. All materials and equipment specified herein and their installation methods shall conform to the latest published version of the National Electric Code.

#### **1.3 SUBMITTALS:**

- A. Submit catalog data showing material information and conformance with specifications. The intended use of each item shall be indicated.

### **PART 2 - PRODUCTS**

#### **2.1 LIGHT FIXTURES:**

- A. Fixture Schedule: Provide in accordance with the Lighting Fixture Schedule, as shown on the drawings.
- B. The fixture catalog numbers listed in the fixture schedule indicate manufacturer, fixture design, quality of design and manufacture, appearance, features, and options required. Lighting fixtures specified will be the basis for comparison in the consideration of fixtures of other manufacturers. Fixtures of lesser quality shall not be considered equivalent.
- C. All fixture component parts shall be manufactured and/or assembled at the manufacturing plant for shipment. The shipment from the fixture manufacturer shall include integrally mounted and/or remote mounted ballasts, where ballasts are required for the proper operation of the fixture lamps.

2.2     **HARDWARE:**

- A.     The Contractor shall provide any necessary hardware for mounting fixtures. The mounting hardware shall be made of materials suitable for the environment installed. Provide materials made from aluminum, non-metallic, or stainless steel in outdoor, damp, or corrosive areas. Enclosures for lighting contactors shall be NEMA rated for the environment in which they are installed. In general, devices installed indoors shall be in NEMA 1 enclosures, and devices installed outdoors shall be in NEMA 3R enclosures.

2.3     **DRIVERS:**

- A.     LED drivers shall be provided as specified by the fixture manufacturer. All drivers shall be replaceable. The power factor shall not be less than 90%. Luminaires shall consume 0.0 Watts in the off state.

2.4     **LAMPS:**

- A.     Provide all lamps as specified. Refer to the Lighting Fixture Schedule on the drawing for the ordering information of lamps. Lamps shall be provided for all lighting fixtures.

2.5     **SPECIAL ACCESSORIES:**

- A.     Provide accessories such as junction boxes, plastic frames, stem, hangers, canopies, couplings, cords, toggle bolts, etc., necessary to mount the fixture in a proper and approved method.

2.6     **CONTROLS**

- A.     Exterior light fixtures shall be controlled by an integral photocell. All light fixtures shall meet the requirements of the most recent version of the International Energy Conservation Code (IECC) adopted by the state of Montana, including automatic shut-off requirements and power density restrictions.

**PART 3 - EXECUTION**

3.1     **FIXTURE MOUNTING:**

- A.     The fixture supplier shall provide necessary mounting devices for all fixtures and shall be responsible for checking the type needed for various soil conditions. Provide a concrete sonotube support for each light bollard. Bollards shall be installed plumb and level.
- B.     The Contractor shall see that all lighting fixtures designed to be installed throughout the project shall be of the correct size and design to properly suit the requirements of each area prior to ordering fixtures.



- C. Contractor shall install fixtures to avoid underground utilities, site equipment, etc.
- D. The Contractor shall provide any additional hardware needed for installation of fixtures, including poles, clamps, brackets, screws, bolts, etc.
- E. Fixtures and other equipment installed in hazardous areas shall be rated for the environment. Provide fittings and seals per NEC.
- I. Properly support and align fixtures and provide all necessary steel shapes for support of the fixtures. Coordinate complete fixture installation with the facility construction. Clean and mount all lighting fixtures with new lamps immediately prior to final inspection.

3.2 CONTROL OF OUTDOOR FIXTURES:

- A. Outdoor light fixtures shall be controlled by means of a photocell and/or time clock, as specified in the written specifications above or in the drawings.

END OF SECTION 265100

## **FLOATING DOCK**

### **PART 1: GENERAL**

#### **1.1 DESCRIPTION**

- A. This work consists of furnishing, assembling and placing a complete standard floating dock with all necessary components including main floating sections, finger sections, section couplers, cleats, shore pins, anchorage weights, pipe pilings, piling attachment couplers, anchorage chains, gangway, gangway attachments, freight, delivery, and installation.

### **PART 2: PRODUCTS**

#### **2.1 PHYSICAL REQUIREMENTS**

- A. Floating dock sections shall be composed of an outer skin of Polyethylene that creates a sealed air floatation chamber or completely encapsulates expanded polystyrene (EPS) foam.
- B. Dock section thickness shall be at least a nominal 15 inches.
- C. Dock design layout is contained in the project planset.

#### **2.2 SHIPMENT AND STORAGE**

- A. Floating dock components may be delivered to the Logan State Park in the fall of 2016 and stored through the winter on-site. The MT FWP shall not be responsible for providing site security. Also the MT FWP shall not be responsible for any theft, damage, or other losses of stored components.

### **PART 3: EXECUTION**

#### **3.1 GENERAL**

- A. The contractor shall perform final installation in April 2017 for the 2017 summer season.
- B. Contractor shall provide opportunity for observation and training of MT FWP maintenance personnel during final floating dock installation.
- C. Contractor shall work in conformance with all applicable permitting including but not limited to: Lincoln County Floodplain Development Permit, Lincoln County Lakeshore Construction Permit, Montana Department of

Environmental Quality 318 Permit, Army Corps of Engineers 404 Permit, and any others that apply.

- D. Contractor shall install dock in conformance with all applicable manufacturer's requirements and specifications, so as to preserve any applicable warranties or guarantees of the products.

#### **PART 4: MEASUREMENT AND PAYMENT**

##### **4.1 GENERAL**

- A. Payment for the dock shall be made after completion of installation for the 2017 summer season.
- B. Upon request of the contractor, the owner may elect to provide a portion of the payment for materials shipped to and stored on-site. However such payment for stored components does not cause MT FWP to be responsible for any theft, damage, or other losses incurred prior to the final installation of the dock. Contractor shall be responsible to provide all components for complete installation regardless of any issue with storage at the project site.

**END OF SECTION**